Soft SUSY Breaking, Scalar Top-Charm Mixing and Higgs Signatures

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Based on hep-ph/0103178
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Workshop on the Future of Higgs Physics
Fermilab, Batavia, Illinois, May 3-5, 2001
Outline

★ Motivation

★ Soft SUSY-Breaking & Minimal FCNC Scheme
   Type-A: Non-Diagonal A-term
   Type-B: Horizontal $U(1)_H$

★ SUSY Radiative Corrections to $cbH^\pm$ & $tch^0$
   Correction to $cbH^\pm$ Vertex
   Correction to $tch^0$ Vertex

★ Collider Phenomenology
   Charm-Bottom Fusion: $cb \rightarrow H^\pm$
   Flavor-Changing Top Decay: $t \rightarrow ch^0$
Two Main Issues for Weak Scale SUSY:

EWsb & Flavor Sector \( \Rightarrow \) un-separable!

Recall SM:

<table>
<thead>
<tr>
<th>e</th>
<th>u</th>
<th>d</th>
<th>( \mu )</th>
<th>s</th>
<th>( \tau )</th>
<th>b</th>
<th>W, Z</th>
<th>t</th>
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<tbody>
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<td>.001</td>
<td>.01</td>
<td>.1</td>
<td>1</td>
<td>10</td>
<td>100 GeV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Radiative EWsb in SUSY:

\[ \Rightarrow \text{A Natural/Real “Topflavor” Model!} \]

\[
\begin{align*}
\frac{dm_{Hu}^2}{dt} &= \frac{3}{8\pi^2} \left[ \Delta_t - g_2^2 M_2^2 - \frac{g_1^2}{5} M_1^2 \right] \\
\frac{dm_{Hd}^2}{dt} &= \frac{3}{8\pi^2} \left[ \Delta_b + \frac{1}{3} \Delta_\tau - g_2^2 M_2^2 - \frac{g_1^2}{5} M_1^2 \right]
\end{align*}
\]

\[
\Delta_t = y_t^2 \left( m_{Hu}^2 + m_{Q3}^2 + m_{\tilde{t}}^2 \right) + A_t^2
\]

\[
\Delta_b = y_b^2 \left( m_{Hd}^2 + m_{Q3}^2 + m_{\tilde{b}}^2 \right) + A_b^2
\]

\[
\Delta_\tau = y_\tau^2 \left( m_{Hd}^2 + m_{L3}^2 + m_{\tilde{\tau}}^2 \right) + A_\tau^2
\]

Generic Higgs Upper Bound in MSSM:

\[
m_{h_0}^2 \lesssim m_z^2 + \frac{N_c}{2\pi^2} \frac{m_t^4}{v^2} \ln \frac{m_{\tilde{t}_1} m_{\tilde{t}_2}}{m_t^2} \lesssim (135 \text{ GeV})^2
\]

\( \Rightarrow \) e.g., \( t \to ch^0 \) is always kinematically allowed.
**SUSY Flavor Sector:** 3-Family Squarks/Sleptons

⇒ Large Portion of SUSY Spectrum/Param. Space

⇒ Adds Complexity & Challenge!

⇒ We Explore FCNC with 3rd+2nd Family-Squarks.

A schematic *(arbitrary)* sample Spectrum.

**MSSM Soft Breaking: Squark sector**

\[ \mathcal{L}_{\text{soft}} \supset -\tilde{Q}_i^\dagger (M_Q^2)_{ij} \tilde{Q}_j - \tilde{U}_i^\dagger (M_U^2)_{ij} \tilde{U}_j - \tilde{D}_i^\dagger (M_D^2)_{ij} \tilde{D}_j + (A_u^{ij} \tilde{Q}_i H_u \tilde{U}_j - A_d^{ij} \tilde{Q}_i H_d \tilde{D}_j + \text{c.c.}) \]

\( M_Q^2, M_U^2, M_D^2 \) & \( A_u, A_d \) are 3 × 3 matrices in squark flavor-space.
Soft SUSY Breaking and $\tilde{t} - \tilde{c}$ Mixings

MSSM Squark Mass-terms and Trilinear $A$-terms:

\[
\mathcal{L}_{\text{soft}}^{\tilde{q}} = -\tilde{Q}_i^\dagger (M_Q^2)_{ij} \tilde{Q}_j - \tilde{U}_i^\dagger (M_U^2)_{ij} \tilde{U}_j - \tilde{D}_i^\dagger (M_D^2)_{ij} \tilde{D}_j \\
+ (A_u^{ij} \tilde{Q}_i H_u \tilde{U}_j - A_d^{ij} \tilde{Q}_i H_d \tilde{D}_j + \text{c.c.})
\]

Generic $6 \times 6$ mass matrix,

\[
\widetilde{\mathcal{M}}_u^2 = \begin{pmatrix}
M_{LL}^2 & M_{LR}^2 \\
M_{LR}^{2\dagger} & M_{RR}^2
\end{pmatrix},
\]

\[
M_{LL}^2 = M_Q^2 + M_u^2 + \frac{1}{6} \cos 2\beta (4m_{\tilde{w}}^2 - m_{\tilde{z}}^2),
\]

\[
M_{RR}^2 = M_U^2 + M_u^2 + \frac{2}{3} \cos 2\beta \sin^2 \theta_w m_{\tilde{z}}^2,
\]

\[
M_{LR}^2 = A_u v \sin \beta / \sqrt{2} - M_u \mu \cot \beta.
\]

Some Comments:

• $\widetilde{\mathcal{M}}_u^2$ is generally non-diagonal & very complicated

• In literature, use crude “Mass Insertion” Approximation, not good for large mixings of $O(1)$.

• Based on compelling Exp/Theor bounds, we construct Minimal FCNC Schemes with $O(1)$ $\tilde{t} - \tilde{c}$ Mixings. ⇒ Consistent with all existing bounds & Exact Diagonalization of $\widetilde{\mathcal{M}}_u^2$, no “mass-insertion” & give New Higgs Signatures in production/decay, etc.
Minimal FCNC Scheme-A: Non-diagonal $A_u$.

By strong CCB and VS bounds together with Exp FCNC bounds, we define, at the weak scale, $A_u$ as the main source of FCNC,

$$\text{Type-A: } A'_u = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & x \\ 0 & y & 1 \end{pmatrix} A$$

$(x, y) = O(1)$, $\Rightarrow$ Large flavor-mixings in $\bar{t} - \bar{c}$ sector, consistent with all low energy EXP-data & theoretical CCB/VL bounds.

For convenience of numerical analysis, define:

- **Type-A1**: $x \neq 0$, $y = 0$.

- **Type-A2**: $x = 0$, $y \neq 0$.

Also, consider, for simplicity,

$$M_{LL}^2 \simeq M_{RR}^2 \simeq \tilde{m}_0^2 I_{3\times3}$$
Charge-Color-Breaking Bounds (CCB)

\[ |A_{u}^{ij}|^2 \leq y_{uk}^2 \left( M_{u_{Li}}^2 + M_{u_{Rj}}^2 + M_{2}^2 \right), \quad k = \max(i, j) \]

\[ |A_{d}^{ij}|^2 \leq y_{dk}^2 \left( M_{d_{Li}}^2 + M_{d_{Rj}}^2 + M_{1}^2 \right), \quad k = \max(i, j) \]

\[ |A_{l}^{ij}|^2 \leq y_{lk}^2 \left( M_{l_{Li}}^2 + M_{l_{Rj}}^2 + M_{1}^2 \right), \quad k = \max(i, j) \]

Vacuum Stability Bounds (VS)

\[ |A_{u}^{ij}|^2 \leq y_{uk}^2 \left( M_{u_{Li}}^2 + M_{u_{Rj}}^2 + M_{l_{Li}}^2 + M_{l_{Rj}}^2 \right), \]

\[ |A_{d}^{ij}|^2 \leq y_{dk}^2 \left( M_{d_{Li}}^2 + M_{d_{Rj}}^2 + M_{\bar{\nu}_p}^2 \right), \]

\[ |A_{l}^{ij}|^2 \leq y_{lk}^2 \left( M_{l_{Li}}^2 + M_{l_{Rj}}^2 + M_{\bar{\nu}_p}^2 \right), \]

where \( k = \max(i, j) \), \( i' \neq j' \), \( p \neq (i, j) \).

Note: \( y_t = \frac{y_{t}^{\text{sm}}}{\sin \beta} \approx 1 \), \( y_{f'} \approx \frac{m_{f'}}{m_t} \ll 1 \)

\( \Rightarrow A_{u,d,l}^{ij} \ll M_{\text{SUSY}} \), except that, remarkably,

\[ \left( A_{u}^{23}, A_{u}^{32}, A_{u}^{33} \right) \ll M_{\text{SUSY}} \]

\( A_{u}^{13,31} \) may be also large, but receive stronger bounds from low energy experimental data; we’ll not consider large \( A_{u}^{13,31} \).
Exp FCNC Bounds on $\tilde{t}/\tilde{\ell}$ Sector

Define:

$$(\delta x)_{IJ}^{ij} \equiv \frac{\langle \mathcal{M}_x^{ij}_{IJ} \rangle}{\left[ \langle \mathcal{M}_x^{ii}_{II} \mathcal{M}_x^{jj}_{JJ} \rangle \right]^{1/2}} \approx \frac{\langle \mathcal{M}_x^{ij}_{IJ} \rangle}{\tilde{m}_0^2}$$

where $x \in (U, D)$, $(I, J) \in (L, R)$, $(i, j) \in (1, 2, 3)$ and

$R \equiv \frac{\tilde{m}_{\text{max}}}{1 \text{ TeV}}.$

\[
\begin{align*}
\delta^U_{LL} & \lesssim \begin{pmatrix} 0.2R & 0.2R \\ 0.2R & 30R^2 \\ 0.2R & 30R^2 \end{pmatrix}, & 
\delta^U_{RR} & \lesssim \begin{pmatrix} 0.2R & ? \\ ? & ? \end{pmatrix}, \\
\delta^U_{LR} & \lesssim \begin{pmatrix} 0.2R & 12R^2 \\ 0.2R & 12R^2 \end{pmatrix}, \\
\delta^D_{LL,RR} & \lesssim \begin{pmatrix} .08R & .2R \\ .08R & 30R^2 \\ .2R & 30R^2 \end{pmatrix}, \\
\delta^D_{LR} & \lesssim \begin{pmatrix} .009R & .07R \\ .009R & .03R \\ .07R & .03R \end{pmatrix},
\end{align*}
\]
First family squarks $\tilde{u}_{L,R}$ decouple $\Rightarrow$ 6 x 6 mass-matrix reduces to 4 x 4,

$$\tilde{M}_{ct}^2 = \begin{pmatrix}
\tilde{m}_0^2 & 0 & 0 & A_x \\
0 & \tilde{m}_0^2 & A_y & 0 \\
0 & A_y & \tilde{m}_0^2 & X_t \\
A_x & 0 & X_t & \tilde{m}_0^2
\end{pmatrix}$$

for squarks ($\tilde{c}_L$, $\tilde{c}_R$, $\tilde{t}_L$, $\tilde{t}_R$), where

$$A_x = x \tilde{A}, \quad A_y = y \tilde{A}, \quad \tilde{A} = A v \sin \beta / \sqrt{2},$$

$$X_t = \tilde{A} - \mu m_t \cot \beta .$$

Stop/Scharm Mass Eigenvalues:

$$M_{c1,2}^2 = \tilde{m}_0^2 + \frac{1}{2} | \sqrt{\omega_+} - \sqrt{\omega_-} | ,$$

$$M_{t1,2}^2 = \tilde{m}_0^2 + \frac{1}{2} | \sqrt{\omega_+} + \sqrt{\omega_-} | ,$$

where $\omega_\pm = X_t^2 + (A_x \pm A_y)^2$.

Mass Spectrum : $M_{\tilde{t}_1} < M_{\tilde{c}_1} < M_{\tilde{c}_2} < M_{\tilde{t}_2}$

$M_{\tilde{t}_1}$ can be as light as 120-300GeV for $\tilde{m}_0 \gtrsim 0.5-1\text{TeV}$
4 × 4 Rotation Matrix of Squark Diagonalization:

\[
\begin{pmatrix}
\bar{c}_L \\
\bar{c}_R \\
\bar{t}_L \\
\bar{t}_R
\end{pmatrix} = 
\begin{pmatrix}
c_{13} & c_1 s_3 & s_1 s_4 & s_1 c_4 \\
-c_2 s_3 & c_2 c_3 & s_2 c_4 & -s_2 s_4 \\
-s_1 c_3 & -s_1 s_3 & c_1 s_4 & c_1 c_4 \\
s_2 s_3 & -s_2 c_3 & c_2 c_4 & -c_2 s_4
\end{pmatrix} 
\begin{pmatrix}
\bar{c}_1 \\
\bar{c}_2 \\
\bar{t}_1 \\
\bar{t}_2
\end{pmatrix}
\]

\[s_{1,2} = \frac{1}{\sqrt{2}} \left[ 1 - \frac{X_t^2 + A_x^2 \pm A_y^2}{\sqrt{\omega^+ \omega^-}} \right]^{1/2}, \quad s_4 = \frac{1}{\sqrt{2}},\]

\[s_3 = 0 (1/\sqrt{2}) \ (\text{if} \ xy = 0 (\neq 0)), \quad s_j^2 + c_j^2 = 1.\]
Table 1. General definition of **Type-B** with $U(1)_H$.

<table>
<thead>
<tr>
<th>$Q_1$</th>
<th>$Q_2$</th>
<th>$Q_3$</th>
<th>$\bar{u}_1$</th>
<th>$\bar{u}_2$</th>
<th>$\bar{u}_3$</th>
<th>$\bar{d}_1$</th>
<th>$\bar{d}_2$</th>
<th>$\bar{d}_3$</th>
<th>$H_u$</th>
<th>$H_d$</th>
<th>$S$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_1$</td>
<td>$h_2$</td>
<td>$h_3$</td>
<td>$\alpha_1$</td>
<td>$\alpha_2$</td>
<td>$\alpha_3$</td>
<td>$\beta_1$</td>
<td>$\beta_2$</td>
<td>$\beta_3$</td>
<td>$\xi$</td>
<td>$\xi'$</td>
<td>$-1$</td>
</tr>
</tbody>
</table>

Below $U(1)_H$ breaking scale and with $S^0$ integrated out, effective operator $\mathcal{O}_j$ with charge $q$:

$$\mathcal{O}_j = c_j \mathcal{F}(f, \bar{f}, H_u, H_d) \Rightarrow c_j \sim \lambda^{|q|}, \quad \lambda \equiv \frac{\langle S^0 \rangle}{\Lambda} \sim 0.22$$

★ **Solving $\mu$-Problem:**

$$\frac{k}{\Lambda^{n-1}} S^n H_u H_d \Rightarrow \mu H_u H_d$$

$$\mu = k \lambda^{n-1} \langle S^0 \rangle \ll \Lambda_{\text{Planck}}, \quad (n = \xi + \xi')$$

★ **Quark Mass Hierarchy Structures:**

$$M_{ij}^{u} \sim \frac{v_u}{\sqrt{2}} \lambda^{\alpha_i + h_j + \xi}, \quad M_{ij}^d \sim \frac{v_u}{\sqrt{2} \tan \beta} \lambda^{\beta_i + h_j + \xi'}$$

★ **The CKM Matrix:**

$$(V_{us}, V_{cb}, V_{ub}) \sim \left(\lambda^{h_1-h_2}, \lambda^{h_2-h_3}, \lambda^{h_1-h_3}\right)$$
**KEY ingredient of our Model Constructions:**

New Condition: \( \alpha_2 = \alpha_3 \)

**The Minimal Type-B Models:**

<table>
<thead>
<tr>
<th>( Q_1 )</th>
<th>( Q_2 )</th>
<th>( Q_3 )</th>
<th>( u_1 )</th>
<th>( u_2 )</th>
<th>( u_3 )</th>
<th>( d_1 )</th>
<th>( d_2 )</th>
<th>( d_3 )</th>
<th>( H_u )</th>
<th>( H_d )</th>
<th>( S )</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>0</td>
<td>3–( \xi )</td>
<td>–( \xi )</td>
<td>–( \xi )</td>
<td>4–( \xi' )</td>
<td>3–( \xi' )</td>
<td>3–( \xi' )</td>
<td>( \xi )</td>
<td>( \xi' )</td>
<td>–1</td>
</tr>
</tbody>
</table>

Quark mass-matrices takes forms of:

\[
M_u \sim \frac{v_u}{\sqrt{2}} \begin{pmatrix}
\lambda^7 & \lambda^4 & \lambda^4 \\
\lambda^6 & \lambda^3 & \lambda^3 \\
\lambda^3 & 1 & 1
\end{pmatrix}, \quad M_d \sim \frac{v_d}{\sqrt{2}} \begin{pmatrix}
\lambda^8 & \lambda^7 & \lambda^7 \\
\lambda^7 & \lambda^6 & \lambda^6 \\
\lambda^4 & \lambda^3 & \lambda^3
\end{pmatrix}
\]

Squark mass-matrices \((M_{LL}^2, M_{RR}^2)\):

\[
M_{LL}^2 \sim \tilde{m}_0^2 \begin{pmatrix}
1 & \lambda & \lambda^4 \\
\lambda & 1 & \lambda^3 \\
\lambda^4 & \lambda^3 & 1
\end{pmatrix}, \quad M_{RR}^2 \sim \tilde{m}_0^2 \begin{pmatrix}
1 & \lambda^3 & \lambda^3 \\
\lambda^3 & 1 & 1 \\
\lambda^3 & 1 & 1
\end{pmatrix}
\]

\( A_u \) Term takes the form of:

\[
A_u \sim A \begin{pmatrix}
\lambda^7 & \lambda^4 & \lambda^4 \\
\lambda^6 & \lambda^3 & \lambda^3 \\
\lambda^3 & 1 & 1
\end{pmatrix}
\]
Define Minimal Type-B $A$-Term: $[y = O(1)]$

$$A'_{u} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & y & 1 \end{pmatrix} A$$

Squarks ($\tilde{u}_L$, $\tilde{u}_R$, $\tilde{c}_L$) decouple from the rest.

$3 \times 3$ matrix, under the basis ($\tilde{c}_R$, $\tilde{t}_L$, $\tilde{t}_R$),

$$\tilde{M}^2_{ct}[B] = \begin{pmatrix} \tilde{m}^2_0 & A_y & x\tilde{m}^2_0 \\ A_y & \tilde{m}^2_0 & -X_t \\ x\tilde{m}^2_0 & -X_t & \tilde{m}^2_0 \end{pmatrix},$$

- **Type-B1**: $x \neq 0$, $y = 0$.
  - similar to **Type-A1**, but due to non-diagonal $M^2_{RR}$
- **Type-B2**: $x = 0$, $y \neq 0$.
  - identical to **Type-A2** (Non-diagonal $A$-Term)

**Type-B1 squark mass spectrum:**

$$M^2_{\tilde{c}_1} = M^2_{\tilde{c}_2} = \tilde{m}^2_0, \quad M^2_{\tilde{t}_1} = \tilde{m}^2_0 - \sqrt{\omega}, \quad M^2_{\tilde{t}_2} = \tilde{m}^2_0 + \sqrt{\omega},$$

$$M_{\tilde{t}_1} < M_{\tilde{c}_1} = M_{\tilde{c}_2} < M_{\tilde{t}_2}$$

**Squark rotation from basis** ($\tilde{c}_R$, $\tilde{t}_L$, $\tilde{t}_R$) into ($\tilde{c}_2$, $\tilde{t}_1$, $\tilde{t}_2$):

$$R[B1] = \begin{pmatrix} c_1 & -s_1/\sqrt{2} & -s_1/\sqrt{2} \\ s_1 & c_1/\sqrt{2} & c_1/\sqrt{2} \\ 0 & -1/\sqrt{2} & 1/\sqrt{2} \end{pmatrix}$$

$$(s_1, c_1) = (x\tilde{m}^2_0, X_t) / \sqrt{\omega}, \quad \omega \equiv (x\tilde{m}^2_0)^2 + X_t^2$$
SUSY Radiative $bcH^\pm$ & $tch^0$ Vertices

Comments: No mass-insertion needed; Exact Feynman Rules, about $O(10)$ Loop-diagrams summed up in each process

★ Corrections to $bcH^\pm$: Squark-Gluino Loops

$$
\Gamma_{H^+b\bar{c}} = i u_c(k_2) (F_L P_L + F_R P_R) u_b(k_1), \\
F_{L,R} = F_{L,R}^0 + F_{L,R}^V + F_{L,R}^S,
$$

$$(F_{L}^0, F_{R}^0) = \frac{g V_{cb}}{\sqrt{2} m_w} (m_c \cot \beta, m_b \tan \beta)$$

One-loop Vertex Corrections in Type-A1:

$$F_{L}^V = 0$$

$$F_{R}^V = \frac{\alpha_s}{3\pi} m_{\tilde{g}} \sum_{j,k} \kappa_{j,k}^R C_0(m_H^2, 0, 0; m_{\tilde{b}_j}, m_{\tilde{g}}, m_{\tilde{u}_k})$$

where $\tilde{u}_k \in (\tilde{c}_2, \tilde{t}_1, \tilde{t}_2), \tilde{b}_j \in (\tilde{b}_1, \tilde{b}_2)$.

Self-energy Corrections in Type-A1:

$$F_{L}^S = 0$$

$$F_{R}^S = \hat{F}_R^0 \frac{\alpha_s s_1 m_{\tilde{g}}}{3\pi m_t} \sum_{j=1,2} (-)^{j+1} B_0(0; m_{\tilde{g}}, m_{\tilde{t}_j})$$

where $\hat{F}_R^0 = V_{tb}[\sqrt{2} m_b \tan \beta / v]$. 
★ Corrections to $tch^0$: Squark-Gluino Loops

$$\Gamma_{\bar{c}th^0} = i\bar{u}(k_2)(F_L P_L + F_R P_R) u_t(k_1)$$

$$F_{L,R} = F_{L,R}^0 + F_{L,R}^V + F_{L,R}^S$$

$$F_{L,R}^0 = 0$$

One-loop Vertex Corrections in Type-A1:

$$F_{L}^V = \frac{\alpha_s}{3\pi} \sum_j \kappa_{Lj} m_t (C_0 + C_{11}) \left[ m_h^2, m_t^2, 0; M_{\tilde{q}_1j}, M_{\tilde{g}}, M_{\tilde{q}_2j} \right]$$

$$F_{R}^V = \frac{\alpha_s}{3\pi} \sum_j \kappa_{Rj} M_{\tilde{g}} C_0 \left[ m_h^2, m_t^2, 0; M_{\tilde{q}_1j}, M_{\tilde{g}}, M_{\tilde{q}_2j} \right]$$

Self-energy Corrections in Type-A1:

$$F_{L}^S \sim 0$$

$$F_{R}^S = \hat{F}^0 \frac{\alpha_s s_\theta M_{\tilde{g}}}{3\pi m_t} \sum_{j=1}^{2} (-)^j B_0(0; m_{\tilde{g}}, m_{\tilde{t}_j})$$

where $\hat{F}^0 = (m_t/v)(\cos \alpha/\sin \beta)$. 
**Higgs Signatures at Colliders**

$\bar{p} p$ or $pp \to H^\pm + X$

- $cb$ & $cs$ fusions at NLO QCD (dash)
- including SUSY Loop (solid)
- $\tan\beta = 15$ (lower) & 50 (upper)

![Graph showing cross sections for Higgs production at different colliders](image)

- $H^\pm$ production via $cb$ (and $cs$) fusions at colliders. Type-A1: $(\mu, M_{\tilde{g}}, \tilde{m}_0) = (300, 300, 600)$ GeV, $(A, -A_b) = 1.5$ TeV.

- $\text{Br}[t \to c h^0] \times 10^3$ is shown for Type-A1 inputs with $(\tilde{m}_0, \mu, A) = (0.6, 0.3, 1.5)$ TeV and $M_{A^0} = 0.6$ TeV. In each entry, $x = (0.5, 0.75, 0.9)$.

<table>
<thead>
<tr>
<th>$M_{\tilde{g}}$</th>
<th>$\tan\beta = 5$</th>
<th>20</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 GeV</td>
<td>(.011, .10, .81)</td>
<td>(.015, .19, 4.6)</td>
<td>(.016, .21, 7.0)</td>
</tr>
<tr>
<td>500 GeV</td>
<td>(.011, .09, .41)</td>
<td>(.015, .13, 1.0)</td>
<td>(.016, .14, 1.2)</td>
</tr>
</tbody>
</table>
Summary

★ Supersymmetry:
EWSB vs Flavor ⇒ Un-separable!
Flavor sector needs to be fully explored.

★ Constructions for
Minimal SUSY FCNC Schemes in Soft Breaking
Type-A: Non-Diagonal $A$-Term
Type-B: Minimal Horizontal $U(1)_H$
⇒ Natural $O(1)$ $\tilde{t} - \tilde{c}$ Mixings, but sufficiently sup-
pressed FCNC with first two families.
(Partial Alignment with quark sector)
⇒ Natural Quark-mass Hierarchy/Mixings

★ SUSY Radiative Corrections to $cbH^\pm$ & $tch^0$

- Correction to $cbH^\pm$ Vertex
- Correction to $tch^0$ Vertex

★ New Channels for SUSY Higgs Signatures

- Charm-Bottom Fusion: $cb \rightarrow H^\pm$
- Flavor-Changing Top Decay: $t \rightarrow ch^0$
Question from audience:
Do you consider renormalization effect to CKM-matrix in the $cbH^\pm$ vertex calculation?
Answer:
No. The relevant CKM element is $V_{cb} \sim 4\%$ for the tree-level $cbH^\pm$ vertex which is at most comparable to or smaller than the leading $SUSY$-$Loop$ correction (enhanced by $\alpha_s$). But the 1-loop correction to $V_{cb}$ itself would be essentially of $O(V_{cb}/16\pi^2) \sim O(2$-loop), and thus fully negligible.