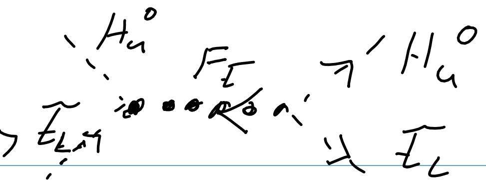
Sparticle Spectra

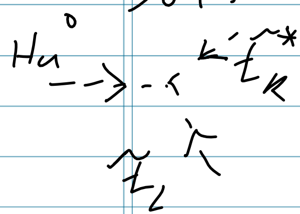
soft

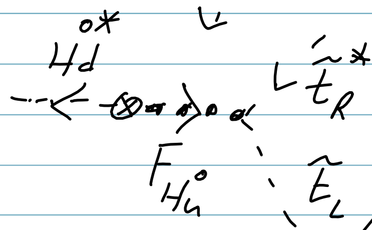


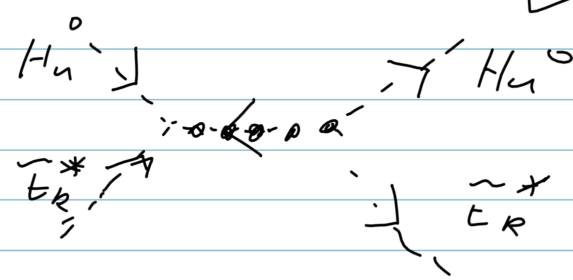
$$m^2_{\tilde t} \begin{pmatrix} m^2_{Q_3} + m_t^2 + \delta_t & v(a_t s_\beta - \mu y_t c_\beta) \\ v(a_t s_\beta - \mu y_t c_\beta) & m^2_{\bar u_3} + m_t^2 + \delta_{\bar t} \end{pmatrix}$$

soft

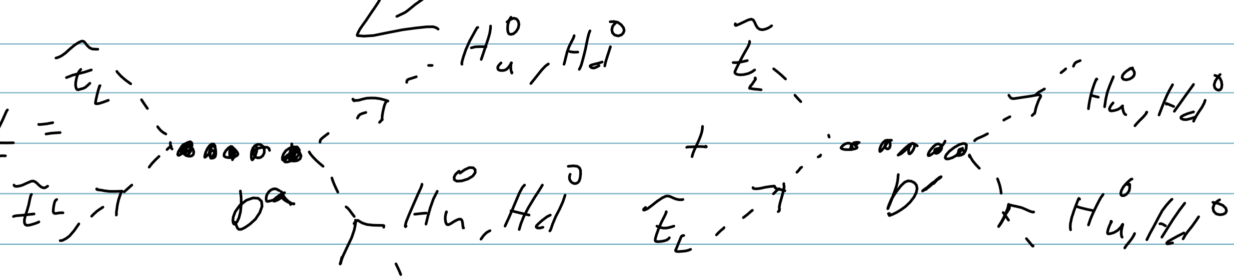
soft susy







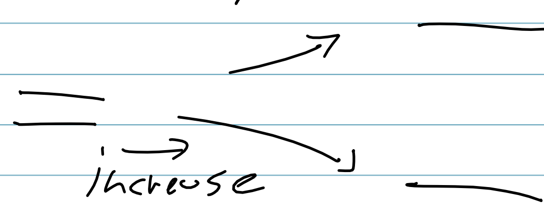
$\delta_t =$



$$\delta_p = (T_3 - Q \sin^2\theta_W) M_Z^2 \cos 2\beta$$

$\tilde t_1, \tilde t_2$

mixing angles in vertices



large mixing can give $-m^2$

bad VEV's

without soft-breaking terms

6×6 matices

$$m^2_{\tilde{u}} = \begin{pmatrix} m_u^\dagger m_u + \delta_u I & \Delta_u \\ \Delta_u^T & m_u^\dagger m_u + \delta_{\bar{u}} I \end{pmatrix}$$

$$m^2_{\tilde{d}} = \begin{pmatrix} m_d^\dagger m_d + \delta_d I & \Delta_d \\ \Delta_d^\dagger & m_d^\dagger m_d + \delta_{\bar{d}} I \end{pmatrix}$$

$$\delta_u = -\tfrac{1}{2} g D^3 - \tfrac{1}{6} g' D'$$

$$\delta_{\bar{u}} = \tfrac{2}{3} g' D'$$

$$\delta_d = \tfrac{1}{2} g D^3 - \tfrac{1}{6} g' D'$$

$$\delta_{\bar{d}} = -\tfrac{1}{3} g' D'$$

$$\sum_p \delta_p = 0$$ at least one $\delta_p \le 0$

suppose $\delta_u \le 0$

let $m_u \vec{\gamma} = m_0 \vec{\gamma}$

eigenvector of fermion mass matrix — smallest eigenvalue

$$(\vec{\gamma}^T, 0)\, m_{\tilde{u}}^2 \begin{pmatrix} \vec{\gamma} \\ 0 \end{pmatrix} \le m_0^2$$

$$(\vec{\gamma}^T, 0) \begin{pmatrix} m_u^\dagger m_u + \delta_u I & \Delta_u \\ \Delta_u^{\dagger} & m_u^\dagger m_u + \delta_{\bar{u}} \end{pmatrix} \begin{pmatrix} \vec{\gamma} \\ 0 \end{pmatrix}$$

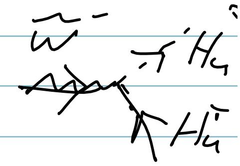
$$= (\vec{\gamma}^T, 0) \begin{pmatrix} m_u^\dagger m_u \vec{\gamma} + \delta_u \vec{\gamma} \\ \Delta_u^\dagger \vec{\gamma} \end{pmatrix}$$

$$= \vec{\gamma}^\dagger m_u^\dagger m_u \vec{\gamma} + \delta_u \vec{\gamma}^\dagger \vec{\gamma}$$

$$= |m_0|^2 + \delta_u < |m_0|^2$$

Charginos : $\tilde{W}^{\pm}$ and $\tilde{H}^{\pm}$

basis $\psi = (\tilde{W}^{+}\, H_u^{+},\ \tilde{W}^{-}, H_d^{-})$



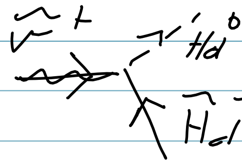
$\mathcal{L} \supset -\frac{1}{2}\, \psi^T M_C\, \psi \quad + h.c.$

soft

$$M_C = \begin{pmatrix} 0 & X^{T} \\ X^{T} & 0 \end{pmatrix}, \quad X = \begin{pmatrix} M_2 & \sqrt{2} s_\beta M_W \\ \sqrt{2} c_\beta M_W & \mu \end{pmatrix}$$

$\downarrow$

$\mu H_u H_d$



SVD $\quad U^* X V^{-1} = \begin{pmatrix} m_{\tilde{C}_1} & 0 \\ 0 & m_{\tilde{C}_2} \end{pmatrix} \qquad m_{\tilde{C}_1} < m_{\tilde{C}_2}$

$$\begin{pmatrix} \tilde{C}_1^{+} \\ \tilde{C}_2 \end{pmatrix} = V \begin{pmatrix} \tilde{W}^{+} \\ H_u^{+} \end{pmatrix} \qquad \begin{pmatrix} \tilde{C}_1^{-} \\ \tilde{C}_2^{-} \end{pmatrix} = U \begin{pmatrix} \tilde{W}^{-} \\ \tilde{H}_d^{-} \end{pmatrix}$$

$$m^2_{\tilde{C}_1, \tilde{C}_2} = \frac{1}{2}\Big[|M_2|^2 + |\mu|^2 + 2m_W \mp \sqrt{(|M_2|^2 + |\mu|^2 + 2M_W^2)^2 - 4|\mu M_2 - M_W^2 \sin 2\beta|} \Big]$$

$$m_W^2 \ll \big| |\mu|^2 \pm M_2^2 \big|$$

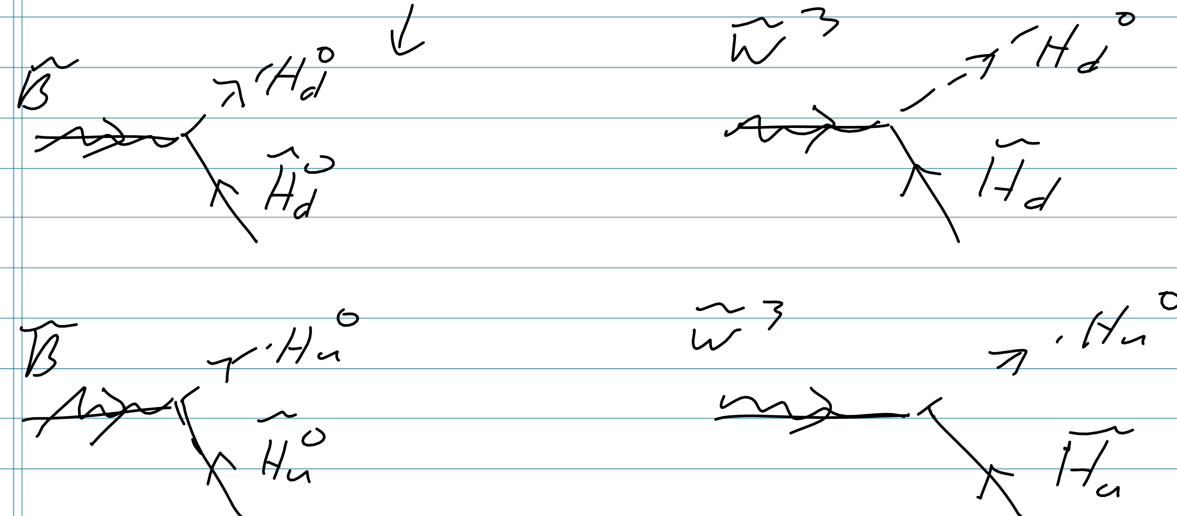
$$m^2_{\tilde{C}_1, \tilde{C}_2} \quad \begin{cases} M_2 \\ |\mu| \end{cases}$$

Neutralinos

$\psi^0 = (\tilde{B}, \tilde{W}^3, \tilde{H}_d^0, \tilde{H}_u^0)$ all mix

$\mathcal{L} \supset -\frac{1}{2} \psi^{0T} M_{\tilde{N}} \psi^0 + h.c.$

$$M_{\tilde{N}} = \begin{pmatrix} M_1 & 0 & 0 & -c_\beta s_W M_Z & s_\beta s_W M_Z \\ 0 & M_2 & M_2 & c_\beta c_W M_Z & -s_\beta c_W M_Z \\ -c_\beta s_W M_Z & c_\beta c_W M_Z & 0 & -\mu \\ s_\beta s_W M_Z & -s_\beta c_W M_Z & -\mu & 0 \end{pmatrix}$$



$s_W = \frac{g'}{\sqrt{g^2+g'^2}}$ $\quad M_Z = \sqrt{g^2+g'^2}\,\frac{v}{2}$

diagonalize $\quad U^* M_N U^{-1}$

$\tilde{N}_i = U_{ij} \psi_j^0$

$M_Z \ll |\mu \pm M_i|$ $\quad \tilde{N}_i = (\tilde{B}, \tilde{W}^3, \frac{1}{\sqrt{2}}(\tilde{H}_u^0 \pm \tilde{H}_d^0))$

$m_{\tilde{N}_i} = (M_1, M_2, |\mu|, |\mu|)$

gluino : M_3