

Neutrino's Mass at the Supersymmetric 3-3-1 model

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lepton masses in MSSM

$$\begin{aligned}
W_{2RC} &= \mu \epsilon \hat{H}_1 \hat{H}_2, \\
W_{2RV} &= \mu_0 a \epsilon \hat{L}_a \hat{H}_2, \\
W_{3RC} &= \epsilon \hat{L}_a f_{ab}^l \hat{H}_1 \hat{l}_b^c + \epsilon \hat{Q}_i f_{ij}^u \hat{H}_2 \hat{u}_j^c \\
&\quad + \epsilon \hat{Q}_i f_{ij}^d \hat{H}_1 \hat{d}_j^c, \\
W_{3RV} &= \epsilon \hat{L}_a \lambda_{abc} \hat{L}_b \hat{l}_c^c + \epsilon \hat{L}_a \lambda'_{aij} \hat{Q}_i \hat{d}_j^c \\
&\quad + \hat{u}_i^c \lambda''_{ijk} \hat{d}_j^c \hat{d}_k^c,
\end{aligned}$$

$$\begin{aligned}
\mathcal{L}_{\text{soft}} &= -\frac{1}{2} \left(\sum_{p=1}^3 m_\lambda \lambda_A^p \lambda_A^p + m' \lambda_B \lambda_B + H.c. \right) \\
&\quad - M_L^2 \tilde{L}^\dagger \tilde{L} - M_l^2 \tilde{l}^c{}^\dagger \tilde{l}^c - M_Q^2 \tilde{Q}^\dagger \tilde{Q} \\
&\quad - M_u^2 \tilde{u}^c{}^\dagger \tilde{u}^c - M_d^2 \tilde{d}^c{}^\dagger \tilde{d}^c - M_1^2 \tilde{H}_1{}^\dagger \tilde{H}_1 \\
&\quad - M_2^2 \tilde{H}_2{}^\dagger \tilde{H}_2 - \left[A_L H_1 \tilde{L} \tilde{l}^c + A_U H_2 \tilde{Q} \tilde{u}^c \right. \\
&\quad + A_D H_1 \tilde{Q} \tilde{d}^c + M_{12}^2 H_1 H_2 + B H_2 L \\
&\quad \left. + C_1 \tilde{L} \tilde{L} \tilde{l}^c + C_2 \tilde{L} \tilde{Q} \tilde{d}^c + C_3 \tilde{u}^c \tilde{d}^c \tilde{d}^c + H.c. \right],
\end{aligned}$$

Neutrino's Masses

$$-(1/2)[\Psi_{MSSM}^{0T} Y_{MSSM}^0 \Psi^0 + H.c.]$$

$$\Psi_{MSSM}^0 = (\nu_e, \nu_\mu, \nu_\tau, -i\lambda_A^3, -i\lambda_B, \tilde{H}_1^0, \tilde{H}_2^0)^T$$

two neutrinos are massless

$$\begin{aligned} & -\frac{\lambda_{abc}}{3} \left(\bar{\nu}_{aL} l_{bR} \tilde{l}_c + \bar{\nu}_{aR}^c l_{bL}^c \tilde{l}_c^* \right) \\ & - \frac{\lambda'_{aij}}{3} \left(\bar{\nu}_{aL} d_{iR} \tilde{d}_j + \bar{\nu}_{aR}^c d_{iL}^c \tilde{d}_j^* \right) + H.c., \end{aligned}$$

Charged Leptons

$$\phi_{MSSM}^+ = (e^c, \mu^c, \tau^c, -i\lambda_W^+, \tilde{H}_2^+)^T,$$

$$\phi_{MSSM}^- = (e, \mu, \tau, -i\lambda_W^-, \tilde{H}_1^-)^T,$$

$$\begin{aligned}\Psi_{MSSM}^\pm &= (\phi_{MSSM}^+, \phi_{MSSM}^-)^T \\ -(1/2)[\Psi_{MSSM}^{\pm T} Y_{MSSM}^\pm \Psi_{MSSM}^\pm + H.c.] &\end{aligned}$$

$$Y_{MSSM}^\pm = \begin{pmatrix} 0 & X_{MSSM}^T \\ X_{MSSM} & 0 \end{pmatrix},$$

0.0005, 0.105, 1.777, 4.3 (in GeV) 81 TeV

No relation charged and neutral matrices

Supersymmetric 331 Model

$$\begin{aligned}
W_2 &= \mu_{0a} \hat{L}_a \hat{\eta}' + \mu_\eta \hat{\eta} \hat{\eta}' + \mu_\rho \hat{\rho} \hat{\rho}' + \mu_\chi \hat{\chi} \hat{\chi}', \\
W_3 &= \lambda_{1abc} \epsilon \hat{L}_a \hat{L}_b \hat{L}_c + \lambda_{2ab} \epsilon \hat{L}_a \hat{L}_b \hat{\eta} + \lambda_{3a} \hat{L}_a \hat{\rho} \hat{\chi} \\
&+ f_1 \epsilon \hat{\eta} \hat{\rho} \hat{\chi} + f'_1 \epsilon \hat{\eta}' \hat{\rho}' \hat{\chi}' + \lambda'_{\alpha ai} \hat{Q}_\alpha \hat{L}_a \hat{d}^c{}_i \\
&+ \lambda''_{ijk} \hat{u}_i^c \hat{d}_j^c \hat{d}_k^c + \lambda'''_{ij\beta} \hat{u}_i^c \hat{u}_j^c \hat{j}_\beta^c \\
&+ \lambda''''_{i\beta} \hat{d}_i^c \hat{J}^c \hat{j}_\beta^c + \kappa_{1i} \hat{Q}_1 \hat{\eta}' \hat{u}_i^c \\
&+ \kappa_{2i} \hat{Q}_1 \hat{\rho}' \hat{d}_i^c + \kappa_3 \hat{Q}_1 \hat{\chi}' \hat{J}^c + \kappa_{4\alpha i} \hat{Q}_\alpha \hat{\eta} \hat{d}_i^c \\
&+ \kappa_{5\alpha i} \hat{Q}_\alpha \hat{\rho} \hat{u}_i^c + \kappa_{6\alpha\beta} \hat{Q}_\alpha \hat{\chi} \hat{j}_\beta^c,
\end{aligned}$$

μ_{0a} , λ_{3a} broke R-parity mixing higgsinos leptons

charged lepton's Masses in the SUSY331

$$\begin{aligned}
& - \frac{\lambda_{3a}}{3} \left[\omega(l_a \tilde{\rho}^+ + \bar{l}_a \overline{\tilde{\rho}^+}) + u(l_a^c \tilde{\chi}^- + \bar{l}_a^c \overline{\tilde{\chi}^-}) \right] \\
& - \frac{1}{2} \mu_{0a} [l \tilde{\eta}'_1{}^+ + \bar{l} \overline{\tilde{\eta}'_1{}^+} + l^c \tilde{\eta}'_2{}^- + \bar{l}^c \overline{\tilde{\eta}'_2{}^-}],
\end{aligned}$$

$$\phi^+ = (e^c, \mu^c, \tau^c, -i\lambda_W^+, -i\lambda_V^+, \tilde{\eta}'_1{}^+, \tilde{\eta}'_2{}^+, \tilde{\rho}^+, \tilde{\chi}'{}^+)^T,$$

$$\phi^- = (e, \mu, \tau, -i\lambda_W^-, -i\lambda_V^-, \tilde{\eta}'_1{}^-, \tilde{\eta}'_2{}^-, \tilde{\rho}'{}^-, \tilde{\chi}'{}^-)^T,$$

$$-(1/2)[\Psi^{\pm T} Y^{\pm} \Psi^{\pm} + H.c.]$$

$$3186.05, 3001.12, 584.85, 282.30, 204.55, 149.41,$$

$$m_e = 0, m_\mu = 0.1052, m_\tau = 1.777 \text{ (in GeV)}$$

Neutrino's Masses in the SUSY331

$$\frac{1}{2}\,\mu_{0a}[\nu_a\tilde{\eta}'^0+\bar{\nu}_a\overline{\tilde{\eta}'^0}]-\frac{\mu_\eta}{2}\,[\tilde{\eta}'^0\tilde{\eta}^0+\overline{\tilde{\eta}'^0}\;\overline{\tilde{\eta}^0}],$$

$$\frac{\lambda_{3a}}{3}[w(\nu_a\tilde{\rho}^0+\bar{\nu}_a\overline{\tilde{\rho}^0})+u(\nu_a\tilde{\chi}^0+\bar{\nu}_a\overline{\tilde{\chi}^0})].$$

$$\Psi^0=\left(\nu_e\nu_\mu\nu_\tau-i\lambda_A^3-i\lambda_A^8-i\lambda_B\tilde{\eta}^0\tilde{\eta}'^0\tilde{\rho}^0\tilde{\rho}'^0\tilde{\chi}^0\tilde{\chi}'^0\right)^T,\\-(1/2)[\left(\Psi^0\right)^TY^0\Psi^0+H.c.]$$

$$-4162.22, 3260.48, 3001.11, 585.19, -585.19, \\453.22, -344.14, 283.14, -272.0, (\mathrm{GeV})$$

$$m_1=0,\; m_2 \approx -0.01,\; m_3 \approx 1.44.$$

$$m_{\nu_e} \propto \lambda_{2ea}\lambda_{2eb}\,E_{ea}E_{eb}\,V^2_{\tilde{\tau}}\,\left(v^2_\chi+v^2_{\chi'}\right)\frac{m_a}{9m^2_{\tilde{\tau}}},$$

$$m_e \propto \lambda'_{\alpha ei} \lambda'_{\alpha' ej} V_j^2 V_b^2 (v_\chi^2 + v_{\chi'}^2) \, \frac{m_{j_\alpha}}{9 m_{\tilde b}^2},$$

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