$$L = \binom{\nu}{e}_L \quad E = (e^c)_L \quad Q = \binom{u}{d}_L \quad U = (u^c)_L \quad D = (d^c)_L$$

$$D \;\rightarrow\; (1_c, 2_L, -1) \quad (1_c, 1_l, 2) \quad (3_c, 2_L, \tfrac{1}{3}) \quad (\bar{3}_c, 1_L, -\tfrac{4}{3}) \quad (\bar{3}_c, 1_L, \tfrac{2}{3})$$

$$\begin{aligned}
5 &\rightarrow (3_c, 1_L, -\frac{2}{3}) + (1_c, 2_L, +1) \\
\overline{5} &\rightarrow (3_c, 1_L, +\frac{2}{3}) + (1_c, 2_L, -1) \\
10 &\rightarrow (\overline{3_c}, 1_L, -\frac{4}{3}) + (3_c, 2_L, +\frac{1}{3}) + (1_c, 1_L, +2) \\
15 &\rightarrow (6_c, 1_L, -\frac{4}{3}) + (1_c, 3_L, +2) + (3_c, 2_L, +\frac{1}{3}) \\
24 &\rightarrow (1_c, 1_L, 0) + (1_c, 3_L, 0) + (8_c, 1_L, 0) \\
&\quad + (3_c, 2_L, -\frac{5}{3}) + (\overline{3_c}, 2_L, \frac{5}{3})
\end{aligned}$$

$$\overline{5} = \begin{pmatrix} d^c \\ d^c \\ d^c \\ e \\ \nu \end{pmatrix}_L \qquad 10 = \left(\begin{array}{ccc|cc} 0 & u^c & u^c & u & d \\ & 0 & u^c & u & d \\ & & 0 & u & d \\ \hline & & & 0 & e^c \\ & & & & 0 \end{array}\right)_L$$

$T_a \in \mathrm{su}(5) \quad \Leftrightarrow \quad T_a = T_a^\dagger,\ \mathrm{tr}\, T_a = 0$

orthonormal basis: $\mathrm{tr}\, T_a T_b = \delta_{ab}/2$

Convenient choice for generators:

$$\left(\begin{array}{c|c} \frac{\lambda_a}{2} & 0 \\ \hline 0 & 0 \end{array}\right) \quad \left(\begin{array}{c|c} 0 & 0 \\ \hline 0 & \frac{\tau_a}{2} \end{array}\right) \quad \frac{\mathcal{N}}{2}\cdot\left(\begin{array}{c|c} -\frac{2}{3}\cdot 1 & 0 \\ \hline 0 & 1 \end{array}\right) \quad \left(\begin{array}{c|c} 0 & * \\ \hline * & 0 \end{array}\right)$$

$a = 1, \ldots, 8$	$a = 9, 10, 11$	$a = 12$	$a = 13, \ldots, 24$
SU(3)$_c$	SU(2)$_L$	U(1)$_Y$	SU(5) extra
		$\mathcal{N} = \sqrt{\frac{3}{5}}$	off diag. Pauli

$$A_\mu^a T^a = \left(\begin{array}{c|c} \begin{array}{l} A^a\frac{\lambda^a}{2} + \sqrt{\frac{3}{5}}A^{12}\frac{Y}{2} \\ a = 1..8 \end{array} & \begin{array}{cc} A^{13}+iA^{14} & A^{19}+iA^{20} \\ A^{15}+iA^{16} & A^{21}+iA^{22} \\ A^{17}+iA^{18} & A^{23}+iA^{24} \end{array} \\ \hline \begin{array}{ccc} A^{13}-iA^{14} & A^{15}-iA^{16} & A^{17}-iA^{18} \\ A^{19}-iA^{20} & A^{21}-iA^{22} & A^{23}-iA^{24} \end{array} & \begin{array}{l} A^a\frac{\tau^a}{2} + \sqrt{\frac{3}{5}}A^{12}\frac{Y}{2} \\ a = 9, 10, 11 \end{array} \end{array}\right)$$

$$= \left(\begin{array}{c|c} \begin{array}{l} G^a\frac{\lambda^a}{2} + \sqrt{\frac{3}{5}}B\frac{Y}{2} \\ a = 1..8 \end{array} & \begin{array}{cc} Y & X \\ Y & X \\ Y & X \end{array} \\ \hline \begin{array}{ccc} Y^* & Y^* & Y^* \\ X^* & X^* & X^* \end{array} & \begin{array}{l} W^a\frac{\tau^a}{2} + \sqrt{\frac{3}{5}}B\frac{Y}{2} \\ a = 9, 10, 11 \end{array} \end{array}\right)$$

Higgs sector: $H(5), \bar{H}(\bar{5}), \Phi(24)$

$$W_{Higgs} = z\mathrm{Tr}\Phi + x\mathrm{Tr}\Phi^2 + y\mathrm{Tr}\Phi^3 + \lambda(\bar{H}\Phi H + M\bar{H}H)$$

Yukawa couplings:

$$\begin{array}{rcl} W_{Yuk} & = & \frac{1}{8}(Y_u)_{ij}10^i 10^j H \quad + \qquad (Y_d)_{ij}10^i\bar{5}^j\bar{H} \\ & & \qquad\downarrow \qquad\qquad\qquad\qquad \downarrow \\ & & (Y_u)_{ij}U^iQ^jH \quad (Y_d)_{ij}D^iQ^j\bar{H} + (Y_e)_{ji}E^iL^j\bar{H} \\ & & \quad Y_u = Y_u^T \qquad\qquad Y_d = Y_e^T @ M_{GUT} \end{array}$$

Soft breaking terms:

$$\begin{aligned} -\mathcal{L}_{soft} \supset\ & (m^2_{\tilde{\bar{5}}})^i{}_j \tilde{\bar{5}}^*_i \tilde{\bar{5}}^j + (m^2_{\widetilde{10}})^i{}_j \widetilde{10}^*_i \widetilde{10}^j \\ & + m^2_H H^* H + m^2_{\bar{H}} \bar{H}^* \bar{H} + \frac{1}{2} M_5 \tilde{G}^*_5 \tilde{G}_5 \\ & + \frac{1}{8}(A_u)_{ij} \widetilde{10}^i \widetilde{10}^j H + (A_d)_{ij} \widetilde{10}^i \tilde{\bar{5}}^j \bar{H} \end{aligned}$$

mSugra IC:

$$\begin{aligned} (m^2_{\tilde{\bar{5}}})^i{}_j &= m_0^2 \delta^i_j \\ (m^2_{\widetilde{10}})^i{}_j &= m_0^2 \delta^i_j \\ (A_u)_{ij} &= a_0 (Y_u)_{ij} \\ (A_d)_{ij} &= a_0 (Y_d)_{ij} \end{aligned}$$

RGE for $m^2_{\widetilde{10}}$

$$16\pi^2 \frac{d}{d\ln\mu}(m^2_{\widetilde{10}})^i{}_j =$$

$$6(A_u^\dagger)^{ik}(A_u)_{kj}$$

$$+4(A_d^\dagger)^{ik}(A_d)_{kj}$$

$$+6(Y_u^\dagger)^{ik}\left\{(m^{2\,T}_{\widetilde{10}})_k{}^l + (m^2_H)\delta^l_k\right\}(Y_u)_{lj}$$

$$+4(Y_d^\dagger)^{ik}\left\{(m^{2\,T}_{\widetilde{5}})_k{}^l + (m^2_{\overline{H}})\delta^l_k\right\}(Y_d)_{lj}$$

$$-\frac{72}{5}g_5^2(m^2_{\widetilde{10}})^i{}_j - \frac{144}{5}g_5^2|M_5|^2\delta^i_j$$

$$+(\Theta_{10})^i{}_k(m^2_{\widetilde{10}})^k{}_j + (m^2_{\widetilde{10}})^i{}_k(\Theta_{10})^k{}_j$$

with field renormalization

$$(\Theta_{10})^i{}_j =$$

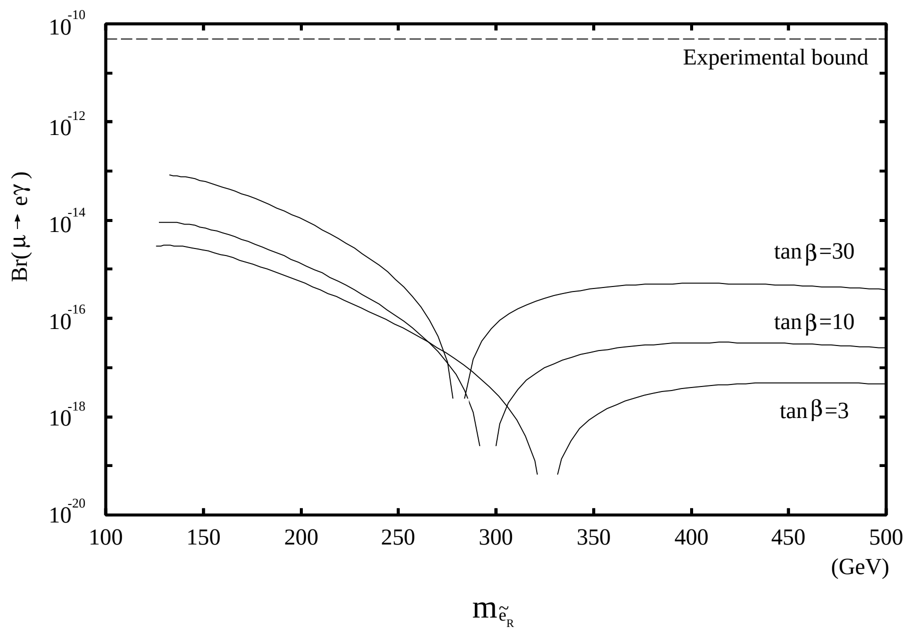
$$3(Y_u^\dagger)^{ik}(Y_u)_{kj}$$

$$+2(Y_d^\dagger)^{ik}(Y_d)_{kj}$$

$$-\frac{36}{5}g_5^2\delta^i_j$$

from Baek, Goto, Okada, Okumura, PRD64 (2001) 095001

Hisano, hep-ph/9806222



The branching ratio of $\mu \to \mathrm{e}\gamma$ in the minimal SUSY SU(5) GUT as a function of the physical right-handed selectron mass, $m_{\tilde{\mathrm{e}}_R}$. Solid lines correspond to the cases for $\tan\beta = 3, 10, 30$. Dashed line represents the present experimental upper bound for this process. Here we take the bino mass $M_1 = 65$ GeV, $a_0 = 0$, and the Higgsino mass $\mu > 0$.

Literature:

- A Supersymmetry primer.
  Stephen P. Martin
  hep-ph/9709356

  Classical overview over Susy and MSSM including some discussion about LFV

- The charged LFV decay $\mu \to e\gamma$ in Susy theories.
  A.Weinberger (diploma thesis)

  Overview over LFV in MSSM+ν_R and Susy GUTs

- Signals for supersymmetric unification.
  Riccardo Barbieri , L.J. Hall
  Phys.Lett.B338:212-218,1994. hep-ph/9408406

  Contains a general explanation why there can be sizeable LFV effects from GUT physics in Susy GUTs, especially Susy SU(5), as well as a discussion about the model dependence based on general considerations

- Muon anomalous magnetic moment, lepton flavor violation, and flavor changing neutral current processes in SUSY GUT with right-handed neutrino.
  Seungwon Baek , Toru Goto , Yasuhiro Okada, Ken-ichi Okumura
  Phys.Rev.D64:095001,2001. hep-ph/0104146

  Contains explicitely the full RGEs for a Susy SU(5) model with ν_R including non-renormalizable operators (thanks Toshi!)

- Unification and Supersymmetry
  Mohapatra (book)

  Material about GUTs, Susy GUTs, MSSM (with RGEs)