T2K and LFV in 2HDM

1. Three Body decay

$l_i \to l_j l_k \bar{l}_k$

$\tau \to \mu^- \mu^+ \mu^-$ $< 10^{-8}$

$\mu^- \to e^- e^- e^+$

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2. Radiative Decay

$l_i \to l_j \gamma$

$\mu \to e \gamma$

3. $\mu \to e$ conversion in nuclei

$\mu^- Al \to e^- Al$

4. LFC muon anamolous magnetic moment

μ $g-2$

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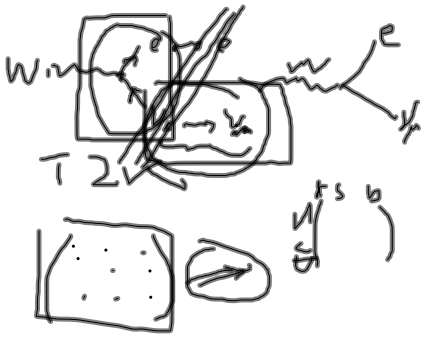

ν oscillation $\neq$ LFV

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Neutrino oscillation data indicate TBM regarded as Zeroth order leptonic mixing matrix

$$U_{TB} = K_\nu \begin{pmatrix} \frac{2}{\sqrt{6}} & \frac{1}{\sqrt{3}} & 0 \\ -\frac{1}{\sqrt{6}} & \frac{1}{\sqrt{3}} & -\frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{6}} & \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{2}} \end{pmatrix} P_\nu$$

$P_\nu = \mathrm{Diag}(e^{i\rho}, e^{i\sigma}, 1)$

$\Rightarrow$ diagonal matrix for Majorana phase

$K_\nu = \mathrm{Diag}(e^{i\alpha}, e^{i\beta}, 1)$

$\Rightarrow$ Additional phase matrix is usually rotated away by definition of charged lepton

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2HDM

$SU(3) \times SU(2) \times U(1)$

with additional N_R & Φ_R $(k = 1,7)$

with hypercharge $Y = 1$

$$\Phi_1 = \begin{pmatrix} G^+ \\ \frac{v + h^0 + iG^0}{\sqrt{2}} \end{pmatrix}$$

$$\Phi_2 = \begin{pmatrix} H^+ \\ \frac{H^0 + iA^0}{\sqrt{2}} \end{pmatrix}$$

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$$\Phi_1 = \begin{pmatrix} G^+ \\ \frac{v + h^0 + iG^0}{\sqrt{2}} \end{pmatrix}; \quad \Phi_2 = \begin{pmatrix} H^+ \\ \frac{H^0 + iA^0}{\sqrt{2}} \end{pmatrix}$$

$$\begin{pmatrix} H \\ h \end{pmatrix} = \begin{pmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{pmatrix} \begin{pmatrix} H^0 \\ h^0 \end{pmatrix}$$

$A^0 = A$

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$$-\mathcal{L}_Y = \bar{Q}_L Y_1^U U_R \tilde{\Phi}_1 + \bar{Q}_L Y_2^U U_R \tilde{\Phi}_2 + \bar{Q}_L Y_2^D D_R \Phi_1 - \bar{Q}_L Y_1^D D_R \Phi_2 + \bar{L}_L Y_1^\nu N_R \tilde{\Phi}_1 + \bar{L}_L Y_2^\nu N_R \tilde{\Phi}_2 + \bar{L}_L Y_1^l l_R \Phi_1 - \bar{L}_L Y_2^l l_R \Phi_2 + \frac{1}{2}\overline{N_R^c} M_R N_R + h.c$$

$$\tilde{\Phi} = i\sigma_2 \Phi^*$$

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$$m_F^{diag} = \frac{v}{\sqrt{2}} V_L^F Y_\alpha^F V_R^{F\dagger}$$

$\alpha = 1, 2$

$F = U, D, \nu, l$

$Y_1^F = Y^F$ ⟶ ~~NO FCNC~~

Jun 12-2:01 AM

$$V = m_1 \Phi_1^\dagger \Phi_1 + m_2 \Phi_2^\dagger \Phi_2 + m_3(\Phi_1^\dagger \Phi_2 + h.c) + \lambda_1(\Phi_1^\dagger \Phi_1)^2 + \lambda_2(\Phi_2^\dagger \Phi_2)^2 + \lambda_3(\Phi_1^\dagger \Phi_1)(\Phi_2^\dagger \Phi_2) + \lambda_4(\Phi_1^\dagger \Phi_2)(\Phi_2^\dagger \Phi_1) + \left[(\lambda_5 \Phi_1^\dagger \Phi_2 + \lambda_6 \Phi_1^\dagger \Phi_1 + \lambda_7 \Phi_2^\dagger \Phi_2)(\Phi_1^\dagger \Phi_2) + h.c\right]$$

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$$m_h^2 = 2\lambda_1 v^2 s_\alpha^2 + \left\{m_2 + \frac{1}{2}(\lambda_3 + \lambda_4 + 2\lambda_5)v^2\right\} c_\alpha^2 + s_{2\alpha}\left(m_3 + \frac{3}{2}\lambda_6 v^2\right)$$

$$m_H^2 = 2\lambda_1 v^2 c_\alpha^2 + \left\{m_2 + \frac{1}{2}(\lambda_3 + \lambda_4 - 2\lambda_5)v^2\right\} s_\alpha^2 - s_{2\alpha}\left(m_3 + \frac{3}{2}\lambda_6 v^2\right)$$

$$m_A^2 = m_2 + \frac{1}{2}($$

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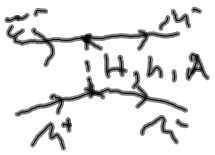

$$\mathcal{L}_Y^0 = \frac{g}{2M_W}\bar{l}_i\left[m_{l_i}\delta_{ij} - K_{ij} - \eta_{ij}\gamma_5\right]l_j(\cos\alpha - \sin\alpha)h - \frac{g}{2M_W}\bar{l}_i\left[m_{l_i}\delta_{ij} - K_{ij} - \eta_{ij}\gamma_5\right]l_j(\cos\alpha + \sin\alpha)H - \frac{ig}{M_W}\bar{l}_i\left[\eta_{ij} - (m_{l_i}\delta_{ij} - K_{ij})\gamma_5\right]l_j A$$

$$K = V_L^{l\dagger} m_l^0 V_R^l + V_R^{l\dagger} m_l^0 V_L^l$$

$$\eta = V_L^{l\dagger} m_l^0 V_R^l - V_R^{l\dagger} m_l^0 V_L^l$$

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