



Lepton Flavor violation

Low energy modes

$$\mu \rightarrow e\gamma, \quad \mu \rightarrow eee,$$

$$\mu^- + A \rightarrow e^- + A, \quad \mu^- + A \rightarrow e^+ + A', \quad \mu^+ e^- \rightarrow \mu^- e^+$$

$$\tau \rightarrow e\gamma, \quad \tau \rightarrow \mu\gamma, \quad \tau \rightarrow eee,$$

$$\tau \rightarrow \mu\mu\mu, \quad \tau^+ \rightarrow e^+ \mu^+ \mu^-, \quad \tau^+ \rightarrow \mu^+ e^+ e^-,$$

$$\tau \rightarrow \mu\pi, \quad \tau \rightarrow e\pi, \quad \tau \rightarrow \mu K_S, \quad K_L^0 \rightarrow \mu e$$

No new physics at LHC

- Signals at LFV rare decays

- For example $\mu \rightarrow eee$ $\mu^- + A \rightarrow e^- + A,$

- What can we learn from pattern of LFV processes?

New physics at LHC

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- For example $\mu \rightarrow eee$ $\mu^- + A \rightarrow e^- + A,$

- What can we learn from pattern of LFV processes?

- SUSY discovered.

$$\mu \rightarrow eee$$

$$\mu \rightarrow e\gamma,$$

- R-parity violation



New physics at LHC



no Signals at LFV



Minimal flavor violation?

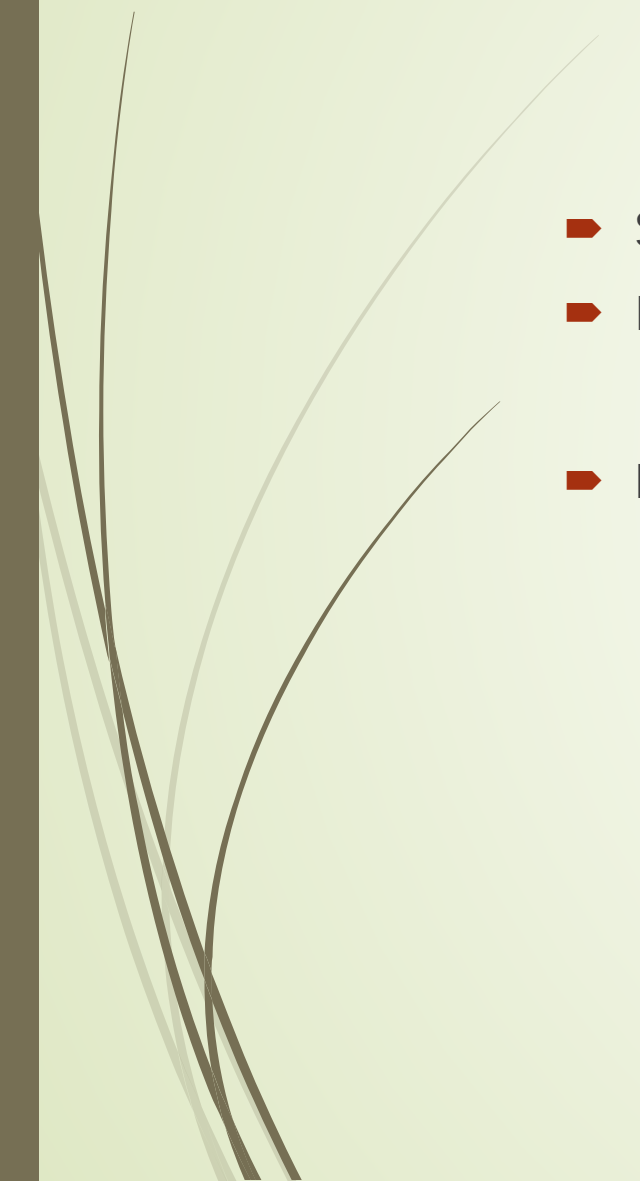


Nightmare scenario

- ▶ No new physics at LHC no LFV
- ▶ Minimal flavor violation?
- ▶ Increasing scale? (naturalness)
- ▶ $(g-2)$ of muon and electron

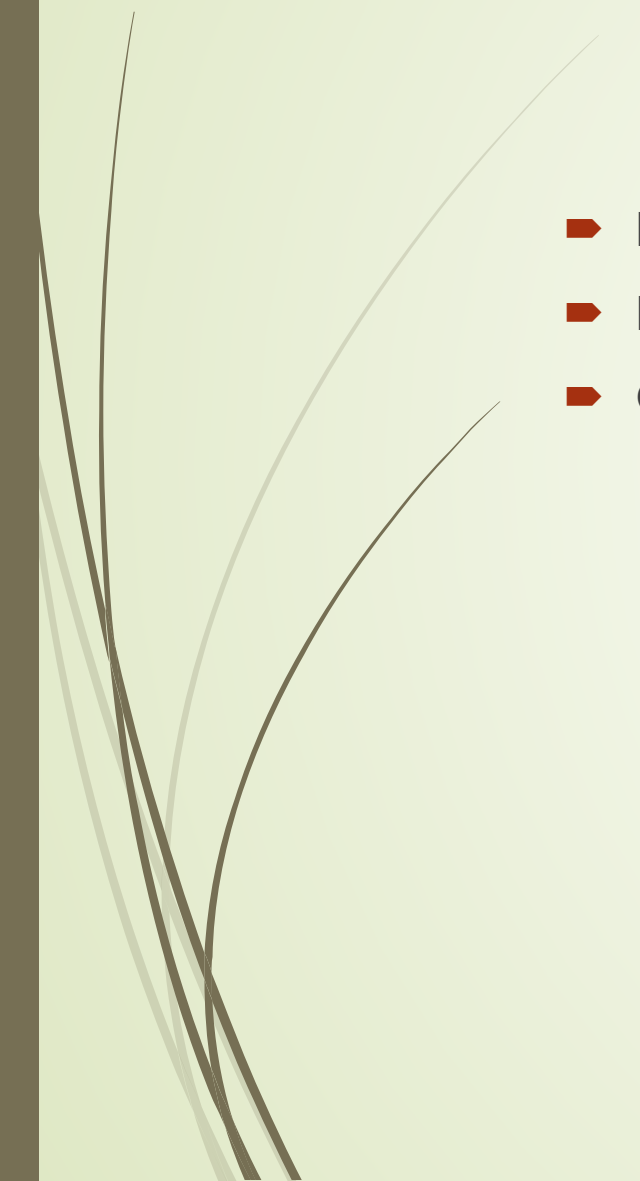


NSI in neutrinos

- ▶ Some model independent connection between NSI in neutrino oscillation
 - ▶ Experiments?
 - ▶ Implications of Signal for NSI in neutrino oscillation
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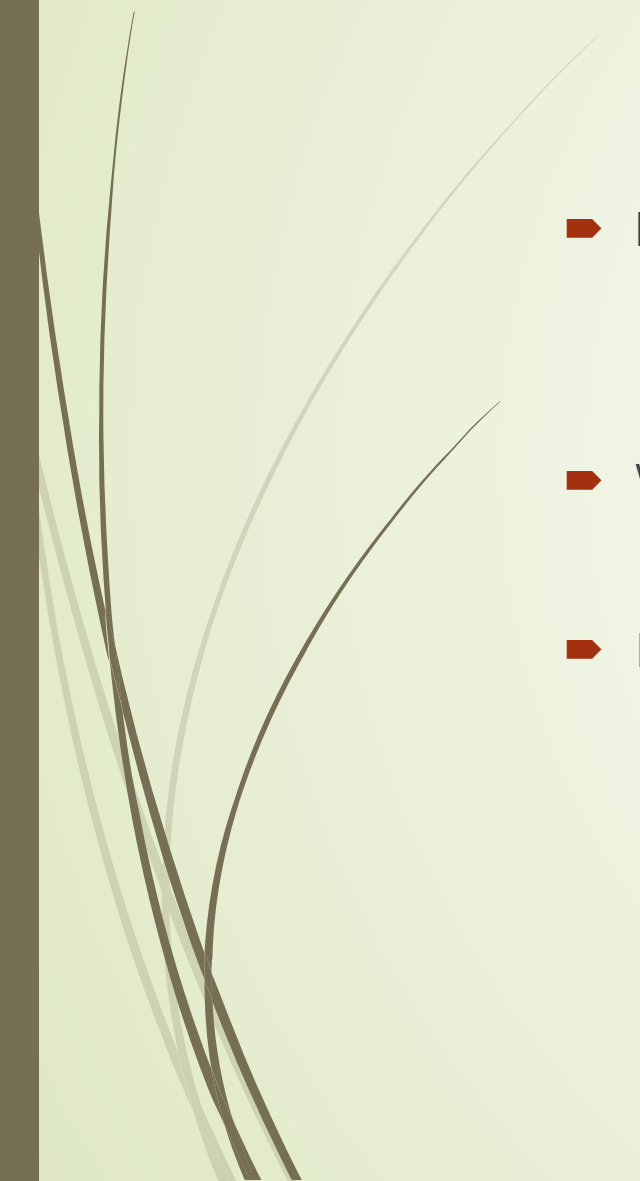


High statistics in LFV

- ▶ Polarized initial state
 - ▶ Helicity structure
 - ▶ CP violation
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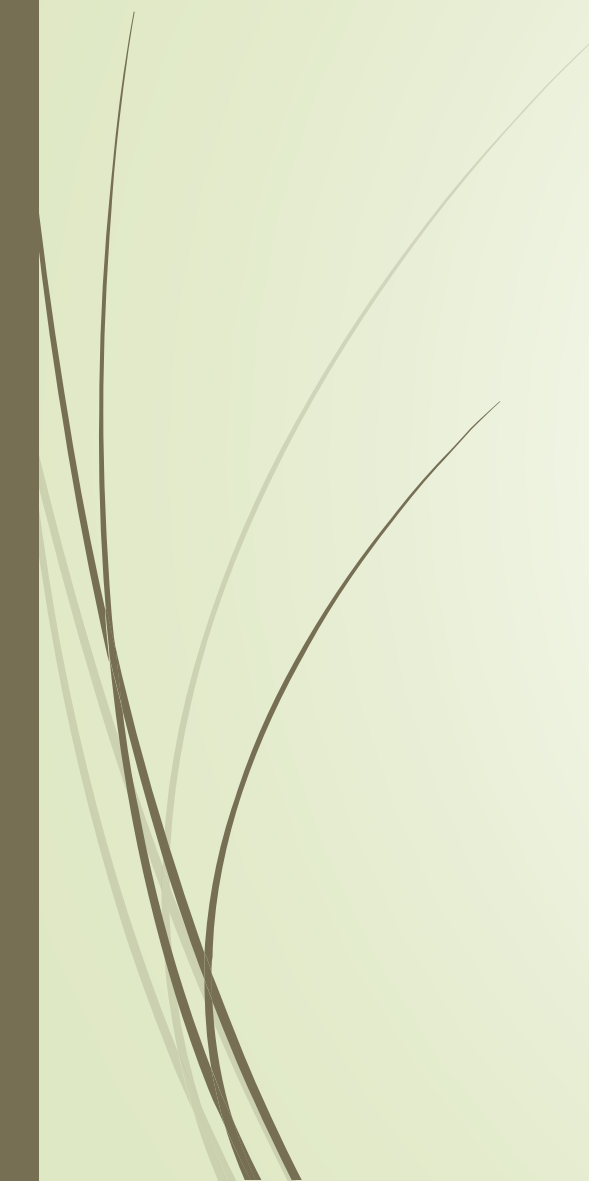


Radiative neutrino mass generation

- ▶ LFV signals in low energy and LHC
 - ▶ Ways to establish the model
 - ▶ Discriminate between models
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Backup



Limits (slide by Stephane Lavignac)

Prospects for CLFV experiments

$\mu \rightarrow e \gamma$:

MEG update should reach 5×10^{-14} in 3 years of acquisition time

$\mu \rightarrow eee$:

Mu3e proposal at PSI aims at $\mathcal{O}(10^{-16})$ (improvement by 4 orders of magn.)

$\mu \rightarrow e$ conversion in nuclei:

The projects mu2e at FNAL and COMET aim at a sensitivity below 10^{-16}

More ambitious projects under study at FNAL and J-PARC $\mathcal{O}(10^{-18})$

τ decays:

The upgraded LHCb experiment should reach a few 10^{-9} on $\tau \rightarrow \mu\mu\mu$

Future B factories (KEKB, SuperB) should probe the $10^{-9} - 10^{-10}$ level

Examples of constraints:

$$\underline{\mu \rightarrow e \gamma}: \quad \frac{C_{\mu e \gamma}^M}{\Lambda_{NP}^2} \langle H^0 \rangle \bar{e} \sigma^{\mu\nu} P_M \mu F_{\mu\nu} + \text{h.c.} \quad (M = L, R)$$

The exp. upper bound $\text{BR}(\mu \rightarrow e \gamma) < 5.7 \times 10^{-13}$ translates into

$$\Lambda_{NP} > \begin{cases} 7.8 \times 10^4 \text{ TeV} & (C = 1) \\ 400 \text{ TeV} & (C = \frac{\alpha_W}{4\pi}) \end{cases}$$

$$\underline{\mu \rightarrow e e e e}: \quad \frac{C_{e e e e}^{MN}}{\Lambda_{NP}^2} (\bar{e} \gamma^\mu P_M e) (\bar{e} \gamma^\mu P_N \mu) + \text{h.c.} \quad (M, N = L, R)$$

The exp. upper bound $\text{BR}(\mu \rightarrow e e e) < 10^{-12}$ translates into

$$\Lambda_{NP} > \begin{cases} 210 \text{ TeV} & (C = 1) \\ 11 \text{ TeV} & (C = \frac{\alpha_W}{4\pi}) \end{cases}$$

→ CLFV starts to be sensitive to scales comparable to kaon physics:

$$\Lambda_{NP} \gtrsim \begin{cases} 2 \times 10^4 \text{ TeV} & (C = 1) \\ 2 \times 10^3 \text{ TeV} & (C = \frac{\alpha_S}{4\pi}) \end{cases} \quad \frac{C}{\Lambda_{NP}^2} (\bar{s}d)(\bar{s}d)$$