Lepton Flavour Violation in Supersymmetric Models

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Based on

J. Hisano and D.N., *Phys. Rev.* **D59** (1999) 116005

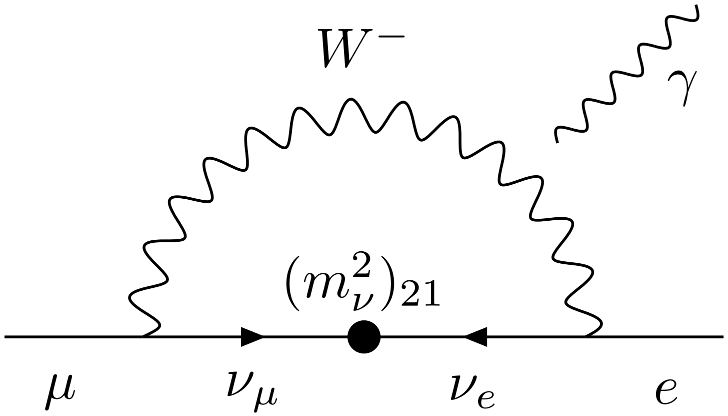
D.N. and Yosuke Uehara, work in progress

Neutrino Oscillation

$$\begin{cases} \Delta m_\nu^2 \neq 0 & \cdots \text{tiny } \nu \text{ mass} \\ \sin^2 2\theta_\nu \neq 0 & \cdots \text{lepton flavour violating} \end{cases}$$

$\Longrightarrow$ Lepton Flavour Number: **No more conserved**.

In the Standard Model (SM) w/ Majorana ν mass terms,



$\mu \to e\gamma$ is predicted to be

$\mathrm{Br}(\mu \to e\gamma) \lesssim 10^{-40}$.

(cf. exp. bound : $< 1.2 \times 10^{-11}$)

In supersymmetric (SUSY) extensions of the SM,

- Extra carriers of flavours (**sleptons and squarks**) :

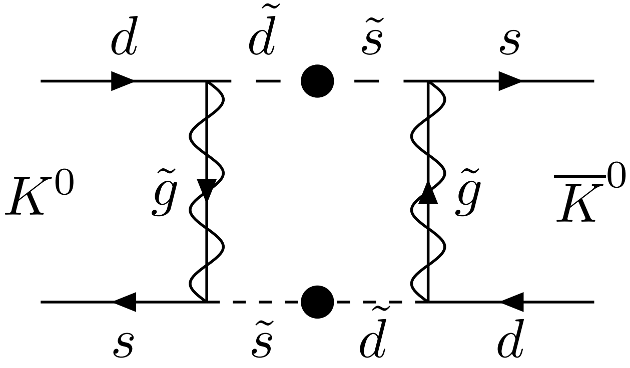
$$\tilde{e},\ \tilde{\mu},\ \tilde{\tau},\ \tilde{\nu}_e,\ \tilde{\nu}_\mu,\ \tilde{\nu}_\tau,\ \tilde{u},\ \tilde{d}, ...$$

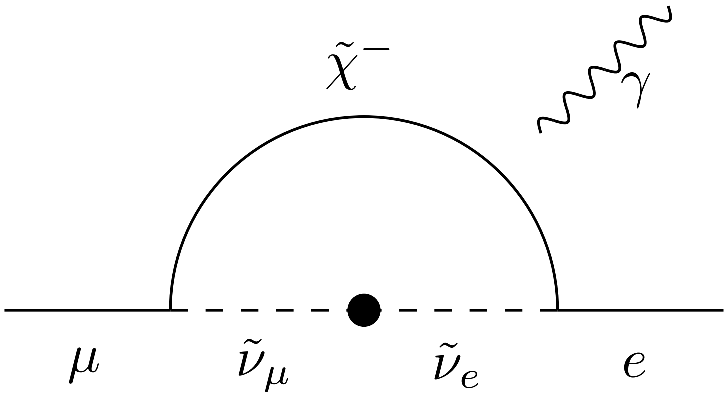
- Extra sources of flavour mixing
  (**soft SUSY breaking terms**) :

$$-\mathcal{L} = (\tilde{e}^\dagger\ \tilde{\mu}^\dagger\ \tilde{\tau}^\dagger) \begin{pmatrix} m^2_{\tilde{e}\tilde{e}} & m^2_{\tilde{e}\tilde{\mu}} & m^2_{\tilde{e}\tilde{\tau}} \\ m^2_{\tilde{\mu}\tilde{e}} & m^2_{\tilde{\mu}\tilde{\mu}} & m^2_{\tilde{\mu}\tilde{\tau}} \\ m^2_{\tilde{\tau}\tilde{e}} & m^2_{\tilde{\tau}\tilde{\mu}} & m^2_{\tilde{\tau}\tilde{\tau}} \end{pmatrix} \begin{pmatrix} \tilde{e} \\ \tilde{\mu} \\ \tilde{\tau} \end{pmatrix} + \ldots$$

Naively, **sizeable** flavour violating rate is expected.

However, for $\mathcal{O}(1)$ slepton/squark flavour mixing, unacceptably large FCNC rates result. ——— **SUSY FCNC problem**

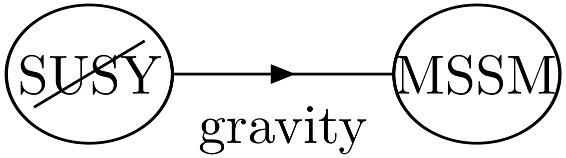


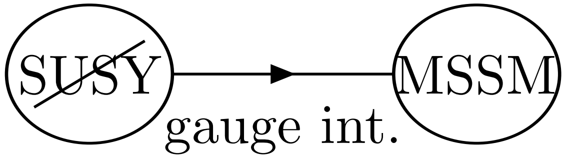


An assumption on the flavour structure needed.

- minimal supergravity
- gauge mediation

$\cdots$





$\cdots$

In this talk we take the minimal SUGRA (mSUGRA) scenario.

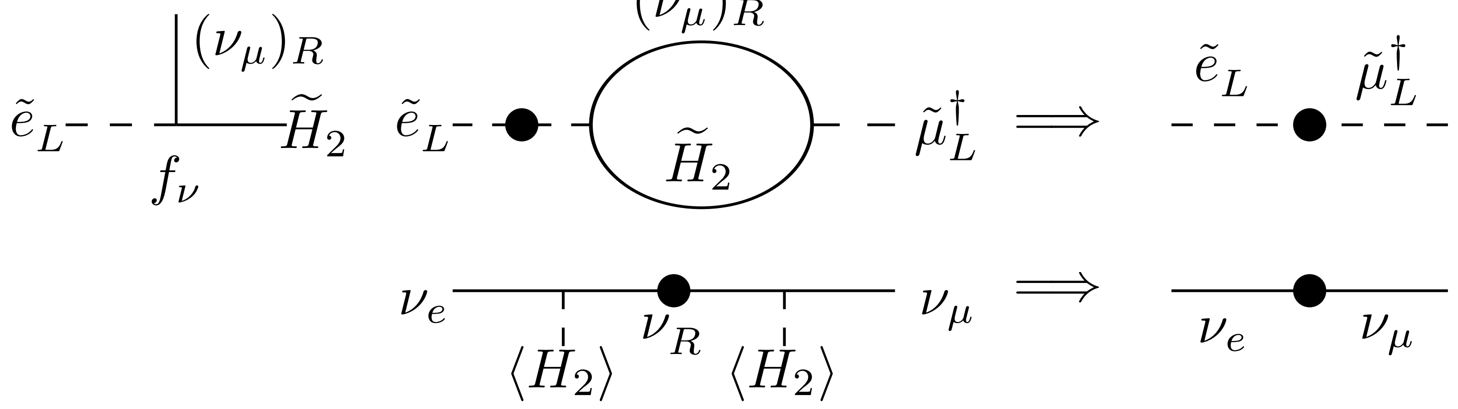
In the mSUGRA scenario we impose

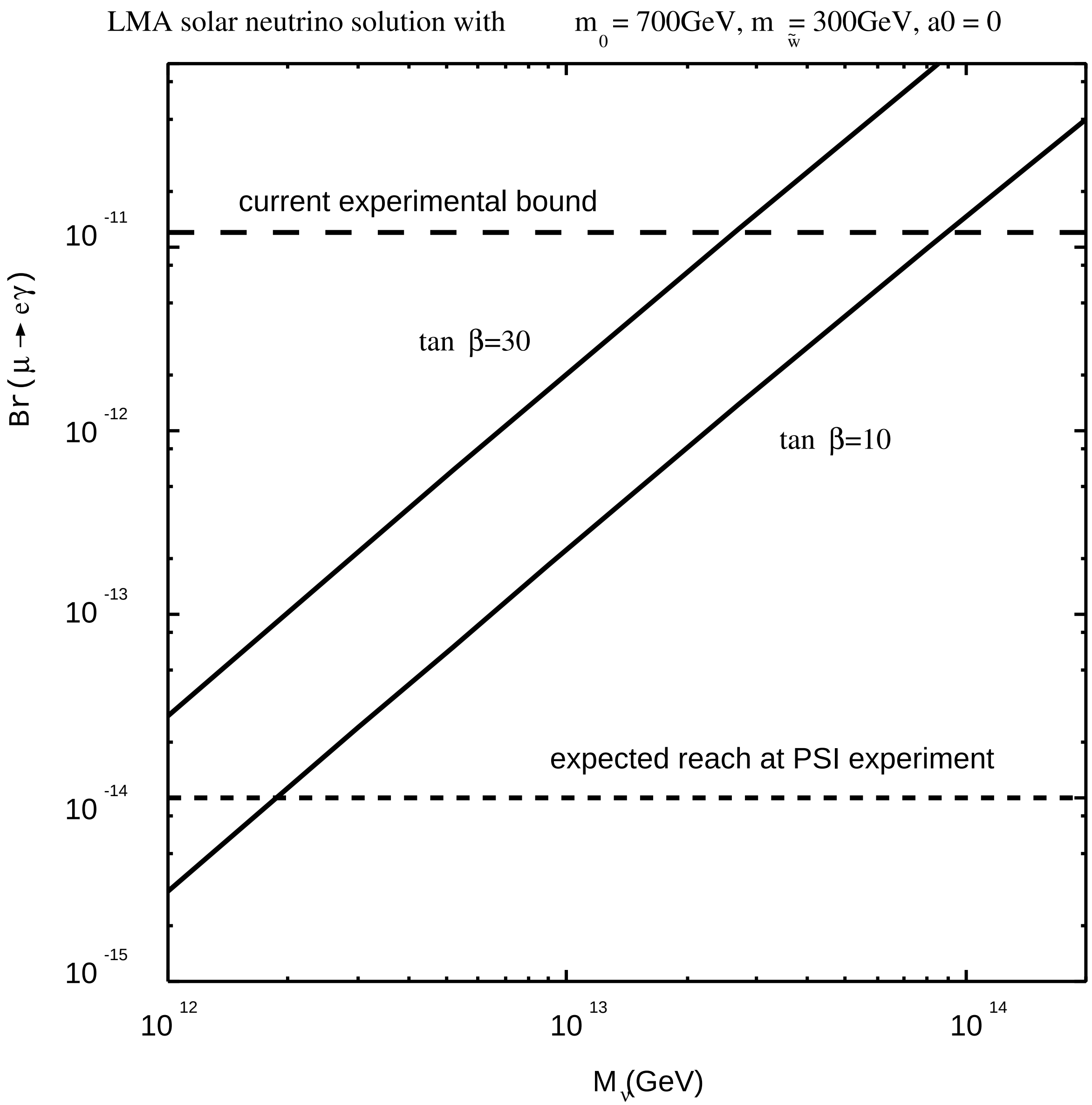
$$\widetilde{m}^2 = \begin{pmatrix} m_0^2 & & \\ & m_0^2 & \\ & & m_0^2 \end{pmatrix}, \quad A_e = a_0 \begin{pmatrix} f_e & & \\ & f_\mu & \\ & & f_\tau \end{pmatrix}$$

at the grav. scale so that no FCNC at tree level. However, flavour violating off-diagonal elements can be **radiatively induced**.

e.g. Minimal SUSY Seesaw Model

$$W = f_{\nu ij} H_2 N_i L_j + \frac{1}{2} M_{\nu ij} N_i N_j + W_{\text{MSSM}}, \quad (M_\nu \sim \mathcal{O}(10^{14})\text{GeV})$$





LMA solar neutrino solution with m_0 = 700GeV, $m_{\tilde{w}}$ = 300GeV, a0 = 0
current experimental bound
tan β=30
tan β=10
expected reach at PSI experiment
Br (μ → eγ)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{12}
10^{13}
10^{14}
M_ν(GeV)

Summary

$\mu \to e\gamma$ search :

- well-motivated by the neutrino oscillation experiments
- powerful probe of the SUSY flavour structure
- current experimental bound: $\mathrm{Br}(\mu \to e\gamma) \sim 10^{-11}$

$\Longrightarrow$ near future improvement $\sim 10^{-14}$ (at PSI).