8th of April 2026 **Quiz number 6**

Phenomenology of Physics Beyond the Standard Model

FS 2026

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Lepton flavour-violating soft SUSY

Consider the following soft SUSY breaking terms:

$$\mathcal{L}_{soft}^{MSSM} \supset -\tilde{\bar{e}}\boldsymbol{m}_{\tilde{e}}^2\tilde{\bar{e}}^\dagger - \tilde{L}^\dagger \boldsymbol{m}_{\tilde{L}}^2 \tilde{L} + \tilde{\bar{e}}\boldsymbol{a}_e \tilde{L} H_d \tag{1}$$

where $\boldsymbol{m}_{\tilde{e}}^2$ and $\boldsymbol{m}_{\tilde{L}}^2$ are the 3×3 mass matrices of the sleptons (respectively right-handed and left-handed sleptons), while $\boldsymbol{a}_e$ is the trilinear sleptons couplings matrix. These terms give rise to the 1-loop diagrams in Figure 1.

- What is the possible decay process that the terms in equation 1 allow ? Which symmetry does not allow this process within the SM ?
- Relate each diagram in Figure 1 to the corresponding soft SUSY term.
- Why is there a strong experimental constraint on some terms of $\boldsymbol{m}_{\tilde{e}}^2$, $\boldsymbol{m}_{\tilde{L}}^2$ and $\boldsymbol{a}_e$? Can you quantify it from Figure 2 ?
- How does the experimental constraint translate into a "selection principle" for setting SUSY breaking terms ? Can all the entries of the matrices be of the same order of magnitude ?

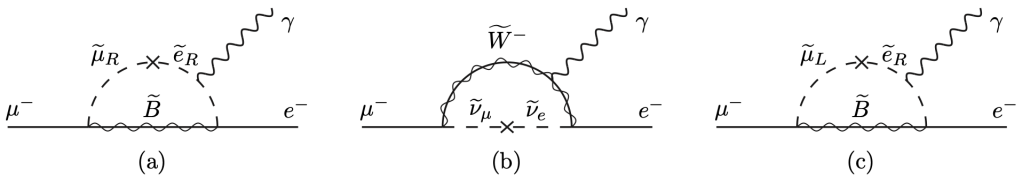


Figure 1: 1-loop diagrams generated from soft SUSY breaking terms

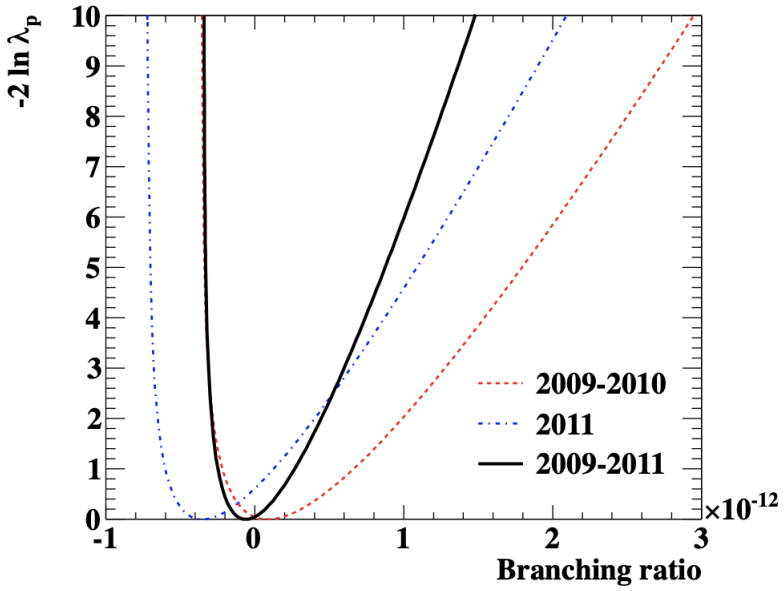


Figure 2: Likelihood scan on $e \to \mu\gamma$ branching ratio [1]

References

[1] J. Adam et al. "New constraint on the existence of the $\mu^+ \to e^+\gamma$ decay". In: *Phys. Rev. Lett.* 110 (2013), p. 201801. DOI: 10.1103/PhysRevLett.110.201801. arXiv: 1303.0754 [hep-ex].