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Revisiting μ-econversion in R-parity violating SUSY

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The μ-e conversion process is one of the most powerful ways to test lepton-flavor-violating (LFV) interactions involving charged leptons. The standard model with massive neutrinos predicts an extremely low rate for μ-e conversion, making this process an excellent probe for testing LFV arising from new physics. Among many theoretical models that can induce LFV, the Supersymmetric model with R-parity violating interactions is one of the most studied for μ-e conversion. In this work, we revisit trilinear R-parity violating interactions for μ-e conversion, considering renormalization group (RG) running effects from high to low energy scales. The μ-e conversion, $\mu \to e\gamma$, and $\mu \to eee$ experimental data are compared to give upper limits on the relevant 15 combinations of the trilinear λ' couplings and 6 combinations of the λ couplings, certain of which are underexplored in previous studies. We find that RG running effects influence the limits by no more than 30\% in most cases, but can improve constraints by $\sim$80\% in certain combinations, which cannot be neglected. In the near future, COMET and Mu2e are expected to begin data-taking and aim to provide the most stringent constraints on μ-e conversion. These next-generation μ-e experiments have the ability to give much more comprehensive examinations on most trilinear coupling combinations than the $\mu \to e\gamma$ and $\mu \to 3e$ decay experiments. The μ-e experiments will not only deepen our understanding of LFV but also provide a crucial way to examine the underlying new physics contributions.

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