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Nucleon-level Effective Theory of μ → e Conversion

The Mu2E and COMET μ→e collaborations plan to advance branching ratio sensitivities by four orders of magnitude, further constraining new sources of charged lepton flavor violation (CLFV). We formulate a non-relativistic nucleon-level effective theory for this process, in order to clarify what can and cannot be learned about CLFV operator coefficients from elastic μ→e conversion. Utilizing state-of-the-art shell model wave functions, we derive bounds on operator coefficients from existing μ→e conversion and μ→eγ results, and estimate the improvement in these bounds that will be possible if Mu2E, COMET, and MEG II reach their design goals. In the conversion process, we employ a treatment of the lepton Coulomb physics that is very accurate, yet yields transparent results and preserves connections to standard-model processes like β decay and μ capture. The formulation provides a bridge between the nuclear physics needed in form factor evaluations and the particle physics needed to relate low-energy constraints from μ→e conversion to UV sources of CLFV.

Primary author: RULE, Evan (U)

Presenter: RULE, Evan (U)