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High-precision muon decay predictions for cLFV experiments

The search for charged Lepton Flavour Violation (cLFV) in muon decay is a sensitive probe to test the Standard Model at the intensity frontier. The MEG II and Mu3e experiments at the Paul Scherrer Institut (PSI) are respectively designed to detect $\mu \to e\gamma$ and $\mu \to eee$ with an unprecedented accuracy. In addition, both experiments are sensitive to cLFV decays of a muon into an invisible axion-like particle X, which is assumed to escape undetected. A viable channel is the two-body decay $\mu \to eX$, whose signature is a monochromatic signal close to kinematic endpoint of the $\mu \to e\nu\bar{\nu}$ background. Another possible process for MEG II is the radiative decay $\mu \to eX\gamma$. The hunt for such elusive signals requires extremely accurate theoretical predictions for simulation and data analysis.

In this poster, a new state-of-the-art computation of $\mu \to eX(\gamma)$ and $\mu \to e\nu\bar{\nu}(\gamma\gamma)$ is presented. Both decays have been implemented in McMule, a novel Monte Carlo framework for the evaluation of higher-order radiative corrections for low-energy processes with leptons. In addition to taking into account all polarisation and mass effects, the signal $\mu \to eX(\gamma)$ includes next-to-leading order corrections, while the background $\mu \to e\nu\bar{\nu}(\gamma\gamma)$ includes next-to-next-to-leading order corrections and logarithmically enhanced terms at even higher orders. The impact of the results on the sensitivity of MEG II and Mu3e on the branching ratio of $\mu \to eX$ is also discussed.

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