Searching for Muon to Electron Conversion Below the $10^{-16}$ Level

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The Muon-to-Electron COntersion, or MECO experiment [1] at Brookhaven National Laboratory seeks to detect coherent, neutrinoless conversion of a muon into an electron in the field of a nucleus with a rate sensitivity four orders of magnitude lower than existing limits. I will review the current limits of charged lepton flavor violation search experiments, which presently range from $10^{-11}$ to slightly below $10^{-12}$ [2]. Recent observations of neutrino oscillation at Super-Kamiokande [3] imply that neutrinos both have mass and mix, but neutrino mixing alone yields an inaccessibly low rate of $\mu^- N \rightarrow e^- N$, hence observation of a signal requires fundamentally new physics. I will highlight a few of the numerous extensions of the Standard Model that predict an observable signal at the $10^{-16}$ level. I will present a detailed description of the MECO experiment, which utilizes several new techniques to reach this level. These include the use of a high Z target and an axially graded solenoidal field in the production region, transport in a combination of solenoids and toroidal sections to filter the muon beam, and situating the muon stopping target within a second axially graded field to increase the acceptance of conversion electrons. If $\Gamma(\mu^-N \rightarrow e^-N)/\Gamma(\mu^-N \rightarrow \nu\mu N') = 10^{-16}$ MECO should observe 5 events with a background of 0.45 events. I will conclude with a summary of the present status of the experiment.

Figure 1: The MECO experiment.

References