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A Familon Search Using the Mu2e Calibration Run

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One major puzzle in particle physics is the replicated lepton families. There appears to be a 'family symmetry' which prevents charged lepton flavor violating (CLFV) processes. If a continuous global lepton family symmetry exists, it leads to associated Goldstone bosons, 'familons', through spontaneous symmetry breaking. The familon can acquire mass if this symmetry is also explicitly broken. Such family symmetry can be tested by searching for the beyond-standard-model (BSM) muon decay,

$\mu^{\pm} \rightarrow f + e^{\pm}$

For μ-decay at rest, the signal would be a mono-energetic electron with its energy determined by the familon mass. Various experiments have established branching ratio limits from $10^{-5} \sim 10^{-6}$ for $\mu^{+} \rightarrow f + e^{+}$, over the familon mass range.

Mu2e has an opportunity to search for familon production using data from a short momentum calibration run at the experiment's start. The goal of the run is a high precision measurement of the (positron) Michel spectrum, to study both the momentum scale and the momentum resolution of the detector, near the decay positron's kinematic endpoint (m_{μ}c/2$\sim$53 MeV/c). This same study will have acceptance for decay familons in the momentum range [35-53] MeV/c.

A familon signal would appear as a line in the reconstructed Michel spectrum. A number of changes to the standard Mu2e running conditions need to be implemented to accomplish the familon search. Assuming the proton beam intensity is reduced to 1/10 nominal, an averaged luminosity of 2.5×10^{8} μ^{+} stops per real second allows, in 1-day of continuous data-taking, to surpass existing branching ratio limits by $\sim$2 orders of magnitude. However, such a beam intensity at 50% magnetic field requires the charged particle tracker to operate outside its Mu2e parameter set, which is now under-study. Nonetheless, even if the proton beam intensity is reduced to 1/1000 nominal, in 1-day of data collection the existing branching ratio limits will be surpassed by an order of magnitude. In both cases limits are set over the familon mass range from [0-40] MeV/c^2.

Are you are a member of the APS Division of Particles and Fields?

Yes

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