Brief Summary

We will study the production of positrons produced from radiative muon capture (RMC) where either an on-shell photon leads to in-medium pair production, or where an off-shell photon leads to an electron-positron pair in the final state $\gamma^* \to e^+e^-$. In both cases the resultant positrons can by misidentified as signal for the charged lepton flavor and (lepton) number violating (CLFNV) process $\mu^- N \to e^+ N^*$. Whether or not this background represents a significant hurdle in the study of CLFNV is a question of whether or not the two processes are kinematically distinguishable.

Our program of research will focus on determining the real- and virtual-photon distributions produced in RMC so that we can ultimately determine the end-point of the positron spectrum from both photon-induced and direct pair production. We will have three major points of emphasis: first we will reformulate the single-nucleon theory of RMC in terms of heavy particle effective theory (HPET), next we will study the role of nuclear physics (e.g. Pauli-blocking) within a simple relativistic Fermi gas model, and, finally, we will study the factorization of Z-enhanced soft-photon corrections (e.g. Coulomb corrections). With these three ingredients we will be able to provide more realistic estimates (as compared to conservative (over)estimates in the literature) of the irreducible RMC backgrounds for CLFNV searches.