

Model-Independent Searches for sub-MeV Dark Particles via Weak Decay Recoil Spectroscopy

Thursday, 21 September 2023 10:00 (30)

Nuclear beta and electron capture (EC) decay serve as sensitive probes of the structure and symmetries of the charged weak force between quarks and leptons. As such, precision measurements of the final-state products in these processes can be used as powerful laboratories to search for new physics from the meV to TeV scale. Significant advances in rare isotope availability and quality, coupled with decades of sensing technique development from the AMO community have led us into a new era of fundamental tests of nature using unstable nuclei. For the past few years, we have taken the approach of embedding radioisotopes in thin-film superconducting tunnel junctions (STJs) to precisely measure the recoiling atom that gets an eV-scale “kick” from the neutrino following EC decay. Since these recoils are encoded with the fundamental quantum information of the decay process, they can also carry unique signatures of weakly coupled beyond standard model (BSM) physics; including neutrino mass and light-mass “dark” particles created within the Q -value window of the decay. These measurements provide a complimentary and (crucially) model-independent portal to the dark sector with sensitivities that push towards synergy between laboratory and cosmological probes. Ongoing and future work in this field include extending the physics reach of recoil experiments with STJs using “on-line” measurements of short-lived systems as well as using macroscopic amounts of harvested rare isotopes in optically levitated nanospheres for direct momentum measurements of the decay recoils.

Primary author(s) : LEACH, Kyle (FRIB and Colorado School of Mines)

Presenter(s) : LEACH, Kyle (FRIB and Colorado School of Mines)