Advanced Background Rejection and Rare Process Searches in the LEGEND Experiment

Marta Babicz
University of Zurich, Zurich, Switzerland

The search for neutrinoless double-beta decay ($0\nu\beta\beta$) remains at the forefront of efforts to uncover the Majorana nature of neutrinos and the mechanisms behind lepton number violation and the matter-antimatter asymmetry of the universe. The LEGEND (Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay) program, combining the strengths of the MAJORANA DEMONSTRATOR and GERDA, employs enriched high-purity germanium (HPGe) detectors and cutting-edge background suppression techniques to pursue these goals. LEGEND-200, currently operating at LNGS, integrates advanced pulse shape discrimination (PSD) and a high-efficiency liquid argon (LAr) veto system to achieve ultra-low backgrounds in the region of interest. In addition to setting a new lower limit on the $0\nu\beta\beta$ half-life of ^{76}Ge, the experiment serves as a platform for refining the instrumental design for LEGEND-1000. This includes novel developments in LAr scintillation light collection and calibration systems critical to PSD performance. Beyond the canonical $0\nu\beta\beta$ search, LEGEND-200 also enables exploration of exotic processes such as neutrinoless double electron capture in ^{36}Ar, leveraging the unique interplay between nuclear and atomic physics. In this talk, I will present the latest results from LEGEND-200, with a focus on PSD methodology, LAr instrumentation, and prospects for probing non-standard physics channels within the LEGEND framework.