INELASTIC NEUTRON SCATTERING STUDIES: RELEVANCE TO NEUTRINOLESS DOUBLE-BETA DECAY

Prof Steven Yates[1], Dr Sharmistha Mukhopadhyay[1], Dr Benjamin Crider[1], Dr Erin Peters[1], Prof Marcus McEllistrem[1], Dr Francisco Prados-Estevez[1], Dr Timothy Ross1, Prof Jeffrey Vanhoy[2]

[1]University of Kentucky
[2] United States Naval Academy

With inelastic neutron scattering (INS), nuclear levels can be non-selectively (statistically) populated, and lifetimes in the femtosecond regime can be determined; low-spin excited states can be observed and transition probabilities can be extracted. These measurements permit the characterization of the low-lying level scheme particularly well and can also supply structural information relevant to the calculation of the nuclear matrix elements for the neutrinoless double-beta decay ($0\nu\beta\beta$) rate. INS experiments were performed at the University of Kentucky Accelerator Laboratory on enriched ^{76}Ge and ^{76}Se scattering samples at inciden neutron energies up to 4.0 MeV. Many new levels were identified, and level lifetimes, transition probabilities, multipole mixing ratios, and other properties were determined. Evidence for a number of previously suggested levels in ^{76}Ge was not found. A comparison of the level characteristics with large-scale shell model calculations yielded excellent agreement, and the $(n,n'\gamma)$ reaction has also been identified as an important potential source of background interference; given the rarity with which $0\nu\beta\beta$ is predicted to occur, knowledge of interferences in the region of interest is crucial. In the $0\nu\beta\beta$ of ^{76}Ge, the experimental signature is a sharp peak at the Q-value of the reaction, 2039 keV. Of particular concern are γ rays from higher-lying excited states in this energy region. Data from INS experiments indicate that there are previously unreported γ rays near 2039 keV, indicating that this region is more complex than previously thought. Similar studies have been performed for other $0\nu\beta\beta$ candidates.