Relevance of the Nuclear Structure of the Stable Ge Isotopes to the Neutrinoless Double-Beta Decay of ^{76}Ge

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Neutrinoless double-β decay (0νββ), the emission of two β^- particles without the emission of accompanying electron antineutrinos, has not been observed but is being sought in several large-scale experiments. 0νββ, a lepton-number-violating nuclear process, will occur only if the neutrinos have mass and are Majorana particles, *i.e.*, they are their own antiparticles. The observation of 0νββ provides perhaps the best method for obtaining the mass of the neutrino, and it is the only practical way to establish if neutrinos are Majorana particles [1].

The rate of 0νββ is approximately the product of (a) the known phase-space factor for the emission of the two electrons, (b) the effective Majorana mass of the electron neutrino, and (c) a nuclear matrix element (NME) squared. The NMEs cannot be determined experimentally and, therefore, must be calculated from nuclear structure models. A focus of many of our recent measurements has been on providing detailed nuclear structure data to guide these model calculations.

At the University of Kentucky Accelerator Laboratory (UKAL), we have performed γ-ray spectroscopic studies following inelastic neutron scattering from ^{76}Ge [2], which is widely regarded as one of the best candidates for the observation of 0νββ, and ^{76}Se, its double-β decay daughter [3]. While ^{76}Ge can be well understood from shell model calculations, ^{76}Se cannot. Moreover, the ground-state deformations of these nuclei appear to differ significantly. To better characterize this transitional region of triaxiality, studies of the lighter stable Ge nuclei have been initiated. In the case of ^{74}Ge, a great deal of information is now available, and shell model calculations explain the low-lying, low-spin structure very well [4].

The experiments, from which a variety of spectroscopic quantities were extracted, employed isotopically enriched scattering samples; the methods have been described previously [5]. From these measurements, low-lying excited states in these nuclei were characterized, new excited states and their decays were identified, level lifetimes were measured with the Doppler-shift attenuation method, multipole mixing ratios were established, and transition probabilities were determined.

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