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Nuclear structure for neutrinoless double-beta decay[1]

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The rate of neutrinoless double-beta decay ($0\nu\beta\beta$) depends on three components: the phase-space factor for the emission of two electrons, the effective Majorana mass of the electron neutrino, and the nuclear matrix element (NME). The NMEs cannot be measured experimentally and must be calculated. Various nuclear structure models have been used for this purpose including the shell model, interacting boson model, quasiparticle random phase approximation, and energy density functional theory, the results of which differ by factors of 2-3 for individual nuclei. Increasing the accuracy of and reducing the uncertainty in the NMEs is considered crucial for extracting the neutrino mass if the half-life of $0\nu\beta\beta$ is measured. To test these calculations and constrain the models, theoretical results are compared with nuclear structure data for reproducibility. Data of importance include level energies, spins and parities, branching ratios, mixing ratios, and transition probabilities. While the structure of the double-beta decay parent and daughter are paramount, many of these nuclei lie in complex regions of nuclear structure and it is necessary to understand the properties of other nuclei in the isotopic chain as well in order to fully characterize the structures involved. Unfortunately, systematic data are not always available to test the models. While improvements in our knowledge of the structure of many $0\nu\beta\beta$ candidates are ongoing, the Ge nuclei have been the focus of numerous recent studies. Various experimental techniques including Coulomb excitation, photon scattering, inelastic neutron scattering, beta decay, and others have been employed to study ^{76}Ge (the $0\nu\beta\beta$ candidate) and other nuclei in the isotopic chain. In this presentation, I will describe recent experimental advances in this region as well as the results of model calculations for comparison.

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