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Nuclear matrix elements for fundamental symmetries

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Atomic nuclei are ideal laboratories to test the fundamental symmetries of Nature in low-energy experiments. Neutrinoless double-beta decay is a lepton-violating process which will only occur if neutrinos are Majorana particles. Decay lifetimes depend on the masses of the neutrinos and on the nuclear matrix elements of the transition. Therefore, nuclear matrix elements are crucial to guide experimental searches and, once detection has been achieved, to extract information on neutrino masses. In this talk I will discuss the theoretical calculation of neutrinoless double-beta decay matrix elements, emphasizing the impact of nuclear structure effects such as pairing and deformation correlations. The nature of dark matter is one the major challenges in physics today. Direct detection experiments aim to measure the scattering of dark matter particles off nuclei. The matrix elements of the scattering process are key for experimental analyses, and to elucidate the interaction between the dark matter particles and the nucleons. I will present state-of-the-art matrix element calculations of the scattering of WIMPs (weakly interacting massive particles) off xenon, which presently set the most stringent limits for direct detection of dark matter.

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