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Experimental results on double-beta decay matrix elements, or what did we learn after so many years of charge-exchange reactions

Charge-exchange reactions of (n,p) and (p,n) type at intermediate energies are a powerful tool for the study of nuclear matrix element in double-beta decay. The present contribution reviews some of the most recent experiments in this context. Here, the (n,p) type reactions are realized through (d,²He), where ²He refers to two protons in a singlet 1S0 state and where both of these are momentum analyzed and detected by the same spectrometer and detector. These reactions have been developed and performed exclusively at KVI, Groningen (NL), using an incident deuteron energy of 183 MeV. Final state resolutions of about 100 keV have routinely been available. On the other hand, the (³He,t) reaction is of (p,n) type and was developed at the RCNP facility in Osaka (JP). Measurements with an unprecedented high resolution of 30 keV at incident energies of 420 MeV are now readily possible. Using both reaction types one can extract the Gamow-Teller transition strengths B(GT₋) and B(GT₊), which define the two “legs” of the 2-neutrino double-beta decay matrix elements. The high resolution available in both reactions allows a detailed insight into the excitations of the intermediate odd-odd nuclei and, as will be shown, some rather unexpected features are being unveiled. Special emphasis will be placed on the double-beta decay nuclei ⁷⁶Ge, ⁹⁶Zr, ¹⁰⁰Mo, ^{128,130}Te and ¹³⁶Xe. The data are being reviewed and some important conclusion may now be drawn about the particulars of the nuclear structure of each system and their impact on the nuclear matrix elements.

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