

Probing Nuclear Beta-Decay by Heavy Ion Charge Exchange Reactions

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Heavy ion charge exchange reactions are of manifold interest for nuclear reaction and structure physics. A new theoretical approach is presented, emphasizing the role of single and double charge exchange reactions for probing nuclear response functions as encountered in single and double beta decay. In particular, a special class of nuclear double charge exchange (DCE) reactions proceeding as a one-step reaction through a two-body process are shown to involve nuclear matrix elements of the same diagrammatic structure as in $0\nu 2\beta$ decay. These correlated Majorana-DCE reactions are distinct from second order DCE reactions which are characterized the best as sequential double single charge exchange (dSCE) carrying a close resemblance to $0\nu 2\beta$ decay. The results suggest that ion-ion DCE reactions are the ideal testing grounds under well-defined dynamical conditions for investigations of double-beta decay nuclear matrix elements. Comparisons to recent single and double charge exchange data measured by the NUMEN collaboration at the LNS Catania are discussed.

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