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Heavy ion double charge exchange reactions and their role in probing double beta decay nuclear matrix elements

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Heavy ion double charge exchange reactions are described by sequential meson-exchange, corresponding to a double single charge exchange (DSCE) reaction mechanism. The theoretical formulation of second-order nuclear reactions and its application to DSCE is represented by a fully quantum mechanical distorted wave 2-step process (second order DWBA). Special emphasis is given to the role of initial and final state ion-ion elastic interactions. Formally, the DSCE reaction amplitudes are shown to be separable into superpositions of distortion factors, accounting for those interactions, and nuclear matrix elements. It is shown that the nuclear response tensors resemble the nuclear matrix elements of $2\nu\beta\beta$ decay in structure but contain in general a considerable more complex multipole and spin structure. The QRPA theory is used to derive explicit expressions for nuclear matrix elements (NMEs). Reduction schemes for the transition form factors are also discussed, by investigating their momentum structure in closure approximation. Formal analogies between the nuclear matrix elements (NME) involved in DSCE reactions and in double beta decay are pointed out. As a first application, calculations are performed for the reaction ^{40}Ca (^{18}O, ^{18}Ne)^{40}Ar at 15 AMeV. Results are compared to the data measured at LNS by the NUMEN Collaboration. Preliminary results of a more systematic analysis, including heavier systems, will also be shown.

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