Contribution ID: **19** Type: **not specified**

Modeling double charge-exchange processes occurring in heavy ion reactions

Tuesday 13 June 2023 09:30 (30 minutes)

Charge-exchange reactions offer the possibility to explore the features of the isospin and spin-isospin channels of the nuclear interaction and associated nuclear structure properties. For instance, they have been recently exploited to measure, in inverse kinematics, the spin-isospin response of neutron drip-line nuclei and to scrutinize the nature of the tetraneutron system.
Owing to the analogies between the vertices of the strong and weak interactions in the isospin and spin-isospin channels, charge-exchange reactions are often investigated also to deduce information on nuclear transition matrix elements (NME) relevant for beta decay. In particular, double charge exchange (DCE) reactions could allow to probe NMEs similar to the ones involved in neutrino-less double beta decay.
In this contribution we discuss new developments related to the theoretical description of DCE reactions with heavy ions. In particular, we model the latter as a sequential meson-exchange, corresponding to a double single charge exchange (DSCE) reaction mechanism. The crucial role of the ion-ion elastic interactions, in the entrance and exit channels, is discussed. Within a DWBA treatment, this allows to single out reaction and structure components from the DCE reaction cross section and to isolate the corresponding NMEs of projectile and target. Several nuclear structure models (QRPA, IBM-like and shell models) are adopted for the evaluation of the NMEs and results are compared with each other. The correlation between the DCE NMEs and the ones characterizing neutrino-less double beta decay is explored.
Calculations are performed for the reactions 40Ca(18O,18Ne)40Ar,
76Se(18O,18Ne)76Ge and 76Ge(Ne20,20O)76Se, and results are compared to the data measured at LNS-Catania and published by the NUMEN Collaboration. This analysis also allows one to estimate the possible contribution of more complex DCE mechanisms, implying a correlation between the two charge-changing nucleons, and/or competing reaction channels associated with multi-nucleon transfer.

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Session Classification: Heavy-ion reactions

Track Classification: Nuclear reactions: Heavy Ions