PROBING SHORT RANGE CORRELATIONS IN HEAVY-ION DOUBLE CHARGE EXCHANGE REACTIONS

C. Garofalo[1,2,*], F. Cappuzzello[1,2,*], M. Cavallaro[2,*], H. Lenske[3,*], for the NUMEN collaboration

[1] *Dipartimento di Fisica e Astronomia "E. Majorana", Università di Catania, Catania, Italy*

[2] *INFN- Laboratori Nazionali del Sud, Catania, Italy*

[3] *Institut fur Theoretische Physik, Justus–Liebig–Universitat Giessen, D-35392 Giessen, Germany*

caterina.garofalo@lns.infn.it

The high momentum transfer encountered in heavy ion Double Charge Exchange (DCE) reactions provides an ideal environment for studying correlation phenomena beyond mean-field in Nuclear Matrix Elements (NMEs). This investigation is of paramount interest for probing the nuclear counterpart of the elusive *neutrinoless double beta (*$0\nu\beta\beta$*)* decay. Currently, the NMEs for such a decay are embedded in a complex puzzle due to the large uncertainty in their determination [1]. Knowing with high precision the NMEs, the neutrino Majorana mass might be determined, provided the $0\nu\beta\beta$ lifetimes [2]. In this respect, the NUMEN [3] project aims to study a wide range of heavy-ion induced DCE reactions in order to provide constraints in the calculation of the NMEs [2].
The DCE reaction is mainly fed through three main competitive processes, namely multi-nucleon Transfer Double Charge Exchange (TDCE) [4], the Double Single Charge Exchange (DSCE) [5] and the Majorana Double Charge Exchange (MDCE) [6]. The latter is a meson exchange process mediated by an effective rank-2 isotensor interaction, coming from the off-shell pion-nucleon DCE scattering. It presents a pronounced short-range character, ranging from the dimension of about 1 fm. Microscopic calculations of MDCE-NMEs have been performed, where the pion potentials play the role of the strong interaction counterparts to the $0\nu\beta\beta$ neutrino potentials. The strong short-range correlations induced by the pion potentials leading to a new type of two-body transition form factors, which are of central importance and highest interest for nuclear spectroscopy.
The multipole structure of pion potentials and NMEs will be discussed. In addition, cross section calculations in eikonal and distorted wave approximation will be presented and compared with experimental data.

References

[1] M. Agostini et al., Rev. Mod. Phys **95**, 025002 (2023).

[2] F. Cappuzzello et al., Prog. Part. Nucl. Phys. **128**, 103999 (2023).

[3] F. Cappuzzello et al., EPJ A **54**, 72 (2018).

[4] J. L. Ferreira et al., PRC **105**, 014630 (2022).

[5] J. I. Bellone et al., Phys. Lett. B **807**, 135528 (2020).

[6] H. Lenske et al., Universe **10**, 202 (2024).