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Search for second order response of nuclei to isospin probes and their connection to double beta decay

In order to get quantitative information on neutrino absolute mass scale from the possible measurement of the $0\nu\beta\beta$ decay half-lives, the knowledge of the Nuclear Matrix Elements (NME) involved in such transitions is mandatory. Interesting studies were performed in the eighties, exploring (π^+ , π^-) Double Charge Exchange (DCE) reactions on different nuclei with the main aim to unveil features of the nuclear response useful for $\beta\beta$ -decay [1]. Unfortunately, such studies were abandoned quite soon, also due to the very different operators governing the two physical processes. One of the key concern was about the indirect excitation of the fundamental double spin-isospin Gamow-Teller modes by the spinless pions. Recently the use of heavy-ion induced double charge exchange (DCE) reactions as tools towards the determination of information on the NME has been proposed in Italy [2] and Japan [3]. The basic point is that there are a number of similarities between the two processes, mainly that the initial and final state wave functions are the same and the transition operators are similar, including in both cases a superposition of Fermi, Gamow-Teller and rank-two tensor components [4].

The NUMEN project at INFN-LNS laboratory in Italy proposes to explore the whole network of nuclear reactions connecting the initial and final nuclear states of the $\beta\beta$ -decay. This includes DCE, Single Charge Exchange (SCE), multinucleon transfer reactions, elastic and inelastic scattering with the purpose to fully characterize the properties of the nuclear wave functions entering in the $0\nu\beta\beta$ decay NMEs. Experimental campaigns are ongoing at INFN-LNS in order to explore medium-heavy ion induced reactions on target of interest for $0\nu\beta\beta$ decay. These studies are complemented by a strong activity on the theoretical side, especially tailored to give a detailed description of the challenging DCE reaction mechanisms. Recent results obtained by the ($^{20}\text{Ne}, ^{20}\text{O}$) DCE reaction and competing channels, measured for the first time using a ^{20}Ne cyclotron beam at 15 AMeV on ^{116}Cd , ^{130}Te and ^{76}Ge targets will be presented at the Conference.

[1] N Auerback et al

Phys Rev Lett 59 1076(1987)

[2] F Cappuzzello et al Eur Phys JA(2018)54:72

[3] M Takaki et al RIKEN Accelerator Progress Rep 47(2014)

[4] F Cappuzzello et al Eur Phys JA(2015)51:145

Primary author: CAPPUZZELLO, Francesco (University of Catania and INFN-LNS, Italy)

Presenter: CAPPUZZELLO, Francesco (University of Catania and INFN-LNS, Italy)

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