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Multi-channel experimental and theoretical approach to the $^{12}C(^{18}O,^{18}F)^{12}B$ single charge exchange reaction at 275 MeV

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In recent years, the search for neutrinoless double beta ($0\nu\beta\beta$) decay has attracted much interest among physicists due to the extraordinary consequences that could derive from its observation. The NUMEN project aims to provide experimental information on the nuclear matrix elements involved in the expression of $0\nu\beta\beta$ decay half-life by measuring the cross section of nuclear double charge exchange reactions. In this framework a full understanding of the reaction mechanisms involved in double and single charge exchange nuclear reactions is mandatory for the purposes of the NUMEN project.

An interesting case study, to test the capabilities of state-of-art nuclear reaction and nuclear structure theories, is the net of nuclear reactions involved in the ^{18}O + ^{12}C collision at 275 MeV incident energy. The experiment has been performed at the INFN-LNS and the experimental results and the theoretical analysis for the single charge exchange, elastic and inelastic scattering, one-neutron addition and one-proton removal nuclear reactions will be discussed during the communication.

The experimental and theoretical study of the $^{12}C(^{18}O, ^{18}O)^{12}C$ elastic and inelastic scattering was performed to access the initial state interaction (ISI) responsible for the distortion of the many-body wave functions of the incoming nuclei. In addition to the ISI and the many-body properties of the nuclear wave functions involved in the studied reactions, the most crucial and debated aspect in the SCE nuclear reactions is the competition between the direct process, proceeding via the deeply studied meson-exchange and the sequential neutron-proton or proton-neutron transfer processes. In this framework, also the $^{12}C(^{18}O,^{19}F)^{11}B$ one-proton knock-out and the $^{12}C(^{18}O,^{17}O)^{13}C$ one-neutron pick-up reaction channels have been analysed to constraint the single particle components of the many-body nuclear wave functions of the involved nuclei.

The goal of this work is to produce and to theoretically analyse the experimental data using state-of-art nuclear structure and reaction theories in a unique comprehensive and coherent theoretical calculation. The holistic approach, applied both to the experimental and the theoretical analysis, is the main feature and novelty of the work presented here and justifies the interest of the NUMEN collaboration.

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