Reaction Dynamics Studies with the Facility EXOTIC at LNL

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The facility EXOTIC [1] for the in-flight production of light weakly-bound Radioactive Ion Beams (RIB's) is now fully operational at the Laboratori Nazionali di Legnaro (LNL, Italy). The production technique employs inverse kinematics two-body reactions induced by heavy-ion beams impinging on light gas targets, such as H_2, D_2, ^{3}He or ^{4}He. Secondary beams of ^{7}Be, ^{8}B and ^{17}F in the energy range 3-5 MeV/u were delivered with intensities of about 250, 1 and 100 kHz, respectively. The Italian Minister of Education, University and Research has recently founded an upgrade of the facility, which will be able to provide in the near future more energetic RIB's.

The ^{17}F secondary beam was used to study the reaction dynamics on ^{58}Ni [2] and ^{208}Pb [3] targets in the energy range around the Coulomb barrier. In particular the scattering process for the system ^{17}F + ^{58}Ni was measured at two colliding energies 20% and 30% higher than the nominal Coulomb barrier. The results were analyzed within the formalism of the coupled-channel code FRESCO [4] to extract the reaction cross section and to investigate the role played by inelastic excitations, transfer channels and by the breakup process $^{17}F \rightarrow {}^{16}O + p$. The comparison with the benchmark reaction ^{16}O + ^{58}Ni showed only a rather moderate enhancement (especially when compared to reactions induced by other weakly-bound projectiles, such as ^{6}He [5], ^{11}Be [6] and ^{8}B [7], on medium-mass targets) of the reaction cross section at the lower secondary beam energy and pointed out the larger relevance of direct channels, especially of the p-stripping process $^{17}F + {}^{58}Ni \rightarrow {}^{16}O + {}^{59}Cu$.

More recently, in the framework of the commissioning of the new detector array EXPADES [8] the scattering process for the system ^{17}O + ^{58}Ni has been measured in the energy range 42.5-55 MeV in 2.5-MeV steps. ^{17}O is the mirror nucleus of ^{17}F and the two projectiles have very similar nuclear shell-model structures but with very different binding energies: $S_n = 4.143$ MeV for ^{17}O and $S_p = 0.600$ MeV for ^{17}F. The reaction cross sections for the two systems, once scaled for the different Coulomb barrier, resulted to be very similar indicating that, in spite of the low projectile binding energy, the breakup process $^{17}F \rightarrow {}^{16}O + p$ plays a minor role in the reaction dynamics at Coulomb barrier energies.

Finally, the interaction of the ^{7}Be secondary beam with a ^{58}Ni target was investigated at two energies around the Coulomb barrier. The data analysis is at an initial stage.

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