International Nuclear Physics Conference INPC2013: 2-7 June 2013, Firenze, Italy

Reaction dynamics and γ spectroscopy of neutron-rich Ne isotopes by heavy-ion reactions

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Heavy ions are one of the most important tool in the study of nuclear reaction mechanisms and nuclear structure. Multi-nucleon transfer reactions, for instance, allow to investigate the properties of exotic systems, moving away from the valley of stability [1]. The combination of a large acceptance magnetic spectrometer with a high efficiency and a high resolution multi-detector array for γ spectroscopy is a key instrument for this purpose, since it allows to perform both reaction dynamics and nuclear structure studies of weakly populated channels [2,3]. In this work, the heavy ion reaction ^{22}Ne+^{208}Pb at 128 MeV beam energy is discussed. The experiment has been performed at Laboratori Nazionali di Legnaro of INFN using the PRISMA-CLARA apparatus [4]. We focus on the study of particle-γ coincidences to investigate the reaction mechanisms and nuclear structure properties of neutron reach Ne isotopes and neighbouring nuclei. Elastic, inelastic and one nucleon transfer cross sections have been measured and angular distributions have been obtained. The data are compared with semiclassical calculations, performed with the code GRAZING [5,6], and with DWBA predictions obtained with the code PTOLEMY [7,8]. In particular, the angular distribution of the 2^+ state of ^{22}Ne has been analysed by DWBA and a similar calculation has been performed for the unstable ^{24}Ne nucleus, using existing data from the reaction ^{24}Ne+^{208}Pb at 182 MeV of bombarding energy (measured at SPIRAL with the VAMOS-EXOGAM setup [9]). The theoretical model gives a good reproduction of the experiment in both cases, pointing to a strong reduction of the β_2^C charge deformation parameter in ^{24}Ne. This follows the trend predicted for the evolution of the quadrupole deformation along the Ne isotopic chain and calls for additional experimental investigation on the collectivity in ^{24}Ne, a nucleus of key importance for understanding the evolution of shell gaps in light systems. The present work demonstrates the validity of heavy ion reactions for both dynamics and nuclear structure studies, providing a useful method which could be further exploited in the future for the investigation of very exotic species.

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