Spectroscopy of moderately neutron-rich nuclei with the CLARA-PRISMA setup

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Multinucleon-transfer reactions and deep-inelastic collisions have been successfully used in the last two decades to study the structure of nuclei far from stability in the neutron-rich side of the nuclear chart. The interest in studying phenomena only present in nuclei very far from stability, especially in neutron-rich medium mass or heavy nuclei, has led to the necessity of new techniques to assign the $\gamma$-transitions to the corresponding reaction product. In a joint effort, $\gamma$-spectroscopy and reaction mechanisms groups belonging to INFN, in collaboration with several European institutes, have developed a new setup by coupling the array of Euroball Clover detectors CLARA [1] to the LNL large acceptance magnetic spectrometer PRISMA [2]. This setup is a step forward in the use of the multi-nucleon transfer and deep-inelastic collisions in $\gamma$ spectroscopy, and aims at measuring in-beam prompt coincidences of $\gamma$-rays detected with CLARA and the reaction product seen by the PRISMA detectors. The setup allows in most cases to assign unambiguously the transitions to the emitting nucleus by identifying the mass (A) and atomic (Z) numbers of the product going into PRISMA. Therefore, it will lower the sensitivity limit in the measurements and allow to study excited states of nuclei away from stability produced with low cross sections. A consistent fraction of the experimental activity is connected to the study of the evolution of the magic numbers in neutron-rich nuclei, as well as to the study of non-yrast states populated in quasi-elastic reactions. In this contribution we will describe the main features of the setup as well as the outcome of the setup. The results of the $^{82}\text{Se} \ (515\text{MeV}) + ^{238}\text{U}$ multinucleon transfer reaction, populating nuclei in the region with $N\approx 50$ will be discussed, focusing on the evolution of the nuclear structure at the $N=50$ shell closure. The ancillary MCP detector array and the feasibility of lifetime measurement, by using the differential RDDS technique in the upcoming setup with the AGATA Demonstrator, will be also discussed.