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Exotic nuclei studied by direct reactions at low momentum transfer - recent results and future perspectives at FAIR

Light-ion induced direct reactions, like for example elastic and inelastic scattering, transfer-, charge exchange-, or knock out-reactions, have been proved in the past, for the case of stable nuclei, to be powerful tools for obtaining nuclear structure information, and were also applied within the last two decades for the investigation of exotic nuclei with radioactive beams in inverse kinematics. In particular, it turned out that in many cases essential nuclear structure information is deduced from high-resolution measurements at low momentum transfer. For the case of inverse kinematics experiments with radioactive beams such measurements can be performed either by using the experimental technique of active targets, or, with even higher luminosities, in future with radioactive beams stored in storage rings, and interacting with thin internal targets. As an example for the application of the active target technique an overview on recent results on intermediate energy small angle elastic proton scattering, a meanwhile well established method for the investigation of nuclear matter distributions of halo nuclei, will be given. The experimental conditions at the future international facility FAIR will provide unique opportunities for nuclear structure studies on nuclei far off stability, and will allow to explore new regions in the chart of nuclides of key importance for nuclear structure and nuclear astrophysics. In particular, the predicted intensities of radioactive beams will allow for the investigation of direct reactions with stored and cooled radioactive beams interacting with internal H, He, etc. targets of the new storage ring NESR. This technique enables high resolution measurements down to very low momentum transfer and provides a gain in luminosity from accumulation and recirculation of the radioactive beams. The design of a complex detector setup is presently investigated by the EXL1 collaboration with the aim to provide a highly efficient, high resolution universal detection system, applicable to a wide class of reactions. It includes a detector array for recoiling target-like reaction products and gamma-rays, surrounding the internal target, as well as a forward detector for fast ejectiles, and an in-ring spectrometer for the detection of beam-like reaction products. A brief overview on the research objectives, the technical concept and the present status of the EXL project, as well as on feasibility studies and first experiments performed or planned at the present ESR storage ring, paving the way towards the full EXL experiment at FAIR, will be presented.

1 EXL: EXotic nuclei studied in Light-ion induced reactions at the NESR storage ring

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