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Measurements of the reaction cross sections of neutron-rich Sn isotopes at the R³B setup

The nuclear equation of state (EoS) plays a key role in many different aspects of modern physics, being fundamental for understanding the structure of nuclear matter, the properties of neutron stars, and the synthesis of heavy elements. While the properties of proton-neutron symmetric matter are relatively well known, the study of asymmetric matter via properties of neutron-rich nuclei became a main frontier of investigation. The asymmetry part of the nuclear EoS is characterized by the symmetry energy at saturation density J and its slope L, with L remaining poorly constrained experimentally. It has been identified that a precise determination of the neutron-removal cross section of neutron-rich nuclei, which is directly related to the neutron skin, would provide a possible constraint on L, with an uncertainty of $\Delta L \approx 10$ MeV.

Such studies can be performed at the R³B (Reactions with Relativistic Radioactive Beams) setup, which allows for the kinematically complete measurements of reactions with high resolution, efficiency, and acceptance. The experiment was conducted in the GSI facility as a part of the FAIR Phase-0 program. The reactions are studied in inverse kinematics with neutron-rich tin isotopes in the mass range A=124-134 on carbon targets of different thicknesses. The reaction products have been measured at beam energies of 400-900 AMeV. A main goal of the experiment is to constrain the L parameter from the accurate measurement of the neutron-removal cross section by comparison to density functional theory.

In addition to the neutron-removal cross section, the experiment also provides valuable data on other reaction cross sections, offering a broader picture of the nuclear reaction mechanisms. In particular, the total interaction and charge-changing cross sections are important for the test of the reaction theory based on Glauber model. This communication presents the motivation for the study, the current analysis results, and findings from the comparison with theoretical predictions.

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