Measurements of the reaction cross sections of neutron-rich Sn isotopes at the R^3B setup*

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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 current focus of investigation. The asymmetry part of the nuclear EoS is characterized by the symmetry energy at saturation density J and its slope L. Constraining these parameters is one of the central issues in nuclear physics, especially since the slope parameter L has not yet been constrained well experimentally [1].

The atomic nucleus is the natural environment to study nuclear matter in the laboratory and the measurement of bulk properties of neutron-rich nuclei may reveal constraints on EoS. 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 much better constraint on L [2].

To this end, an experiment was performed at the R^3B setup 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 in a kinematically complete manner. 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, one can deduce other reaction cross sections from these experimental data. In this communication the first preliminary results of the total charge-changing cross sections will be discussed. This observable quantifies the probability for reaction processes where at least one proton was removed from the projectile and is related to the radius of the proton distribution in the nucleus. This measurement allows for the test of the reaction theory through a comparison of experimentally obtained charge-changing cross sections with theoretical ones as a function of measured [3] and calculated charge radii.

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[2] T. Aumann *et al.*, Physical Review Letters **119** (2017) 262501.

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