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Constraining the nuclear equation of state

Nuclear equation of state (EOS) describes the relationship between state variables such as density, pressure and temperature of a nuclear system. It is usually expressed as the energy per nucleon of a particular nuclear medium. Constraining parameters of nuclear EOS of asymmetric nuclear matter (where asymmetry lies in proton to neutron number) is of immense importance for understanding not just the properties of neutron-rich nuclei but also for the physics of neutron stars, mergers and other astrophysical phenomena. To accomplish this goal in terrestrial laboratories one must probe observables sensitive to changes in EOS parameters of exotic unstable nuclei which were for a long time experimentally unreachable. With the advent of radioactive ion beam facilities, the region further from the valley of stability became accessible.

An experiment with the aim of constraining the symmetry-energy slope L to ± 15 MeV was held recently using large acceptance spectrometer R3B-GLAD at the GSI accelerator facility as a part of the FAIR Phase-0 campaign \cite{r3b}. Gathered data will be used to obtain total reaction, charge changing, total neutron-removal and total Coulomb-excitation cross sections along the tin isotopic chain for ^{124,128,132,134}Sn. The objective behind the choice of these measurements lies in the existence of correlation between neutron-removal and Coulomb-excitation cross sections and the respective observables familiar for having a tight connection with the parameter L: neutron-skin thickness and the ground-state dipole polarizability \cite{tom, maza}. Stringent constraints on L will be derived from comparison of cross sections extracted from data with predictions of RMF calculations employing different energy density functionals.

[1] R3B-Collaboration, https://www.r3b-nustar.de/.
[2] T. Aumann, C. A. Bertulani, F. Schindler, and S. Typel, Phys. Rev. Lett., 119:262501, Dec 2017.
[3] X. Roca-Maza and N. Paar., Prog. Part. Nucl. Phys., 101:96–176, 2018.

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