Coulomb excitations in neutron-rich tin isotopes as a tool to constrain nuclear equation of state

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The nuclear Equation Of State (EOS) governs both tiny nuclear systems such as heavy nuclei and vast and violent stellar environments such as supernova explosions and neutron star mergers. Investigating it in great detail could therefore provide new insights into a lot of open questions in physics concerning nuclear structure and dynamics of processes occurring in the Universe. Scientific efforts to experimentally constrain the parameters of symmetry energy term which reflects the influence of proton-to-neutron number imbalance in the system, are divided into two main fronts — research at modern accelerator facilities and astrophysical observations.

A novel approach has emerged to constrain the slope of symmetry energy, i.e., the linear coefficient in expansion of symmetry energy around saturation density and to benchmark energy density functionals by measuring the Coulomb-excitation cross section, σ_C, of neutron-rich nuclei at relativistic energies [1]. This particular cross section correlates with dipole polarizability, α_D, a well-established observable for constraining slope of the symmetry energy [2]. However, in contrast to α_D, σ_C benefits from the simplicity of measurement procedure and analysis.

An experiment was conducted using the large acceptance spectrometer R3B-GLAD at the GSI accelerator facility near Darmstadt (Germany) as a part of the FAIR Phase-0 campaign [3]. Neutron-rich tin isotopes in the mass range 124–134 were produced in fragmentation and fission reactions at energies close to 1 GeV/u and impinged onto the lead target which provided a strong field to induce Coulomb excitations. At these energies, de-excitation follows mostly through the emission of gammas and neutrons which were detected using CALIFA gamma calorimeter and NeuLAND neutron detector [4]. The remaining fragment nuclei were detected in the rest of the setup which altogether offers kinematically complete measurement.

In this contribution the results of the analysis will be presented as well as a comparison with mean-field calculations performed using various relativistic and non-relativistic energy density functionals.

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