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Dipole response of exotic nuclei and the equation of state

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The properties of exotic nuclei are ideally studied in inverse-kinematics experiments at high beam energies using the FRS-LAND facilities at GSI, allowing exclusive measurements of all projectile-like residues following the electromagnetic excitation of the projectile in a high-Z target (Pb). At beam energies of ~500 AMeV electromagnetic excitations are dominated by dipole transitions. In an experiment utilizing secondary beams of neutron-rich Sn isotopes 129-132Sn and neighbouring nuclei with similar A/Z ratio we have observed a substantial fraction of dipole strength at energies below the giant dipole resonance (GDR). For 130Sn and 132Sn this strength is located in a peak-like structure around 10 MeV and exhibits a few percent of the Thomas-Reiche Kuhn (TRK) sum-rule strength [1]. Several calculations (see e.g.[2,3]) predict the appearance of dipole strength at low excitation energies in neutron-rich nuclei, often referred to as pygmy dipole resonance (PDR). In a macroscopic picture, the PDR is discussed in terms of a collective oscillation of excess neutrons out of phase with the core nucleons. Recent random-phase-approximation calculations show a strong correlation of the PDR strength to the density dependence of the symmetry energy and thus a link to the neutron skin size [4,5]. We will discuss consequences from the experimental findings in 130Sn, 132Sn [5] and 208Pb [6] for the neutron-skin sizes, the symmetry energy and the neutron equation of state (EoS).

Using the same setup and detection technique the Nickel isotopic chain was investigated utilizing relativistic secondary beams of 57-72Ni, with energies of approximately 500 AMeV, enabling the access to the dipole strength distribution in the continuum. Cross sections for selected isotopes will be presented.

In order to investigate the appearance of the pygmy-strength over a wide range of A/Z ratios, we decided to examine the case of 32Ar, a so-called “proton-rich” nucleus. Several calculations predict the appearance of pygmy-strength for this nucleus [7,8]. In Summer 2008 an experiment was carried out addressing the dipole response of 32-34Ar at the LAND-FRS setup after a recent upgrade. We will report on the status of data analysis and statistics to be expected.

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