International Nuclear Physics Conference INPC2013: 2-7 June 2013, Firenze, Italy

Probing the neutron skin thickness in collective modes of excitation

N. Paar

Physics Department, Faculty of Science, University of Zagreb, Croatia

Contact email: *npaar@phy.hr*

Collective motion in neutron-rich nuclei provides important information on the underlying structures evolving due to asymmetry in the proton-to-neutron number [1,2]. Theoretical frameworks based on nuclear energy density functional enable microscopic fully self-consistent description of nuclear excitation response, which in conjunction with recent experimental data on pygmy dipole strength, dipole polarizability, quadrupole excitations, etc., provides valuable insight into the size of the neutron skin thickness ΔR_{np} [3-6]. This quantity is directly connected to the properties of nuclear equation of state, i.e. the symmetry energy that is of paramount interest for nuclear structure, nuclear reactions and astrophysics. Covariance analysis in connection to the energy density functionals allow discerning relevant correlations between response properties in finite nuclei, properties in symmetric nuclear matter and neutron skin thicknesses. Of particular interest are correlations between the observables related to excitation phenomena in finite nuclei and the symmetry energy at saturation density (J), slope of the symmetry energy (L), and ΔR_{np}. Recently the relativistic nuclear energy density functional has been employed in a number of studies with the aim to determine in a unified way ΔR_{np}, J, and L from nuclear modes of excitation. Model calculations are realized in terms of the self-consistent random phase approximation, based on effective interactions with density dependent meson-nucleon couplings. In the study of isovector and isoscalar dipole response in ^{68}Ni, ^{132}Sn, and ^{208}Pb [3], the evolution of low-energy pygmy dipole strength (PDS) has been analyzed as a function of the density-dependence of the symmetry energy for a set of relativistic effective interactions. The occurrence of PDS is predicted in the response to both the isovector and isoscalar dipole operators, and its strength is enhanced with the increase of the symmetry energy at saturation and the slope of the symmetry energy. Charge-exchange excitations in neutron-rich nuclei provide another feasible approach to constrain ΔR_{np}, J, and L. Recent study showed that the excitation energies of the anti-analog giant dipole resonance (AGDR), obtained using a set of density-dependent effective interactions which span a range of the symmetry energy at saturation density, supplemented with the experimental values, provide a stringent constraint on value of the neutron skin thickness [6]. Therefore, a measurement of the excitation energy of the AGDR in (p, n) reactions using rare-isotope beams in inverse kinematics, provides a valuable method for the determination of neutron-skin thickness in exotic nuclei [6].

[1] N. Paar, J. Phys. G: Nucl. Part. Phys. 37, 064014 (2010).
[2] E. Khan, N. Paar, and D. Vretenar, Phys. Rev. C 84, 051301 (2011).
[3] D. Vretenar, Y. F. Niu, N. Paar, and J. Meng, Phys. Rev. C 85, 044317 (2012).
[4] J. Piekarewicz, et al., Phys. Rev. C 85, 041302(R) (2012).
[5] X. Roca-Maza et al., Phys. Rev. C 87, 034301 (2013).
[6] A. Krasznahorkay, N. Paar, D. Vretenar, M.N. Harakeh, Phys. Lett. B 720, 428 (2013).