Self-consistent models for the collective excitation phenomena in exotic nuclei*

Nils Paar[1], Tamara Nikšić[2,3], Peter Ring[2], Dario Vretenar[3], Robert Roth[1], Panagiota Papakonstantinou[1], Heiko Hergert[1]
[1]Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstrasse 9, D-64289 Darmstadt, Germany
[2]Physik-Department der Technischen Universität München, D-85748 Garching, Germany
[3]Physics Department, Faculty of Science, University of Zagreb, Croatia

The excitation phenomena in exotic nuclei are analyzed in the framework of the fully self-consistent relativistic quasiparticle random-phase approximation (RQRPA) based on the Relativistic Hartree-Bogoliubov model[1]. The DD-ME1 density-dependent meson-exchange interaction is used in the effective mean-field Lagrangian, and pairing correlations are described by the pairing part of the finite-range Gogny interaction D1S. The properties of the low-lying excitations are studied along isotopic chains[2], showing that the electric pygmy dipole resonance (PDR) is already at moderate proton-neutron asymmetry located above the neutron emission threshold, resulting with important implications for (γ,γ') experiments and r-process calculations[3]. Furthermore, a method is suggested for determining the size of the neutron skin[4], based on the difference of the excitation energies of the Gamow-Teller resonance and the isobaric analog state[5]. The RQRPA model is also employed in the studies of beta-decay half-lives of nuclei of the relevance for the r-process[6], and for description of the multipole response in nuclei close to the proton drip-line[7].

An alternative approach for self-consistent description of collective excitation phenomena is formulated in the Hartree-Fock + RPA model which is based on the realistic nucleon-nucleon interactions with explicit treatment of interaction-induced correlations via the unitary correlation operator method (UCOM)[8]. The binding energies, charge radii, one-body density distributions, and single-particle energies are evaluated along the nuclide chart, to investigate the utility of the UCOM Hartree-Fock model for a consistent description of the nuclear ground state. It is shown that one can improve the structure properties by extending the model space to include the long-range correlations (e.g. many-body perturbation theory), and by implementing an additional phenomenological two-body correction, which simulates the missing three-body interactions. Fully self-consistent UCOM-RPA model is employed for the ab-initio studies of giant resonances along the nuclide chart.

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