Neutron and proton densities and deformations in drip-line nuclei*

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The continuum effects in nuclei close to the drip-line determine the spatial extentions of the neutron subsystem. Nuclei with large neutron-to-proton ratios have neutron skins, which manifest themselves in an excess of neutrons at distances greater than the radius of the proton distribution. In addition, some drip-line nuclei develop very extended halo structures. The neutron halo is a threshold effect; it appears when the valence neutrons occupy weakly bound orbits. The nuclear skins and halos in medium-heavy and heavy nuclei can be described within the self-consistent Hartree-Fock-Bogoliubov theory. It is demonstrated that skins, halos, and surface thickness can be analyzed in a model-independent way in terms of nucleonic density form factors. Such an analysis allows for defining a quantitative measure of the halo size. The systematic behavior of skins, halos, and surface thickness in even-even nuclei is discussed [1], and the dependence of the halo size on the piring force is analyzed [2].

Coupling to the particle continuum is essential for a description of pairing correlations in weakly bound nuclei. It can be shown that both resonant and non-resonant continuum phase space is active in creating the pairing field. The influence of positive-energy phase space is quantified in terms of localizations of states within the nuclear volume [3]. The pairing binding energy acts against a development of an infinite rms radius that characterizes standard ℓ=0 mean-field eigenfunctions in the limit of vanishing binding energy. As a result, neutron radii of even-N nuclei do not diverge in the limit of vanishing Fermi energy. Only the broken-pair ground states of odd-N nuclei can exhibit diverging neutron radii, provided an ℓ=0 (or 1) quasiparticle state appears near the Fermi surface. We also show that the pairing-increased (although not infinite) rms radii of even-N nuclei result from the coupling to low-lying ℓ=0 continuum, which is always available for virtual pair excitations, independently of what are the angular momenta of least-bound single-particle levels. [4].

Deformation of nuclei near the neutron drip line is still a difficult and open problem in the nuclear structure physics. One possible attempt at solving it is to introduce a local-scaling point transformation to allow for modifying the asymptotic properties of the deformed three-dimensional Cartesian harmonic oscillator wave functions. The resulting single-particle bases are very well suited for solving the Hartree-Fock-Bogoliubov equations for deformed drip-line nuclei. The results suggest that for light even-even elements the most weakly-bound nucleus has an oblate ground-state shape [5]. Systematic study of deformations near the neutron drip line is presented [6].

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