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Nucleon effective mass and the ground-state properties

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Theoretical and experimental investigations of neutron-rich nuclei represent one of the most fascinating and abundant sources of new information about nuclear structure. The varied properties of atomic nuclei impose significant requirements on theoretical approaches. One of the most effective microscopic methods for investigating ground-state properties is the Hartree-Fock (HF) approach, which utilizes a self-consistent mean-field based on the Skyrme energy density functional (EDF) [1]. The HF calculations with the Skyrme interactions provide a rather satisfactory description of the radii, binding energy, and single-particle (s.p.) energy of magic nuclei. However, the calculated density of the s.p. states near the Fermi level is less than what has been observed experimentally.

The s.p. states around the Fermi energy are known to be strongly affected by the nucleon effective mass profile at the surface. As shown in [2], the isoscalar correction term in the Skyrme EDF produce a surface-peaked effective mass. These dynamical correlations demonstrate that the density of states increases as the effective mass gets enhanced at the surface of nuclei [2,3]. The inclusion of the correction term in the Skyrme EDF leads to a decline in the accuracy of the binding energy description. In this work, we readjust the parameters of the Skyrme interaction and isoscalar correction term in order to reach more accurate description of binding energies and density of the s.p. states near the Fermi level [4]. As an illustration, we study impact of surface-peaked effective mass on the ground-state properties of magic nuclei 40,48Ca 132Sn, and 208Pb.

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