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Exotic Shapes and Shape Coexistence in Light Atomic Nuclei: Employing a Hamiltonian Without Parametric Correlations

Contenu

We present the results of a systematic analysis of exotic nuclear shapes and shape coexistence in light nuclei region. The study was carried out using mean field theory in its phenomenological realisation involving a deformed Woods-Saxon potential with the so-called universal parametrisation without parametric correlations. The parametric correlations have been removed with the help of the Inverse Problem Theory and the Monte-Carlo approach. The model was first examined by comparing the energy spectra of individual nucleons in spherical nuclei with experimental energies, the quality of reproduction of these energies by the model is satisfactory and approximately the same for all spherical nuclei. Another test of the predictive power of the model was performed by calculating the equilibrium deformations of the ground state of numerous nuclei in the studied region. Comparison of the theoretical predictions for equilibrium deformation with the experimental data showed a good correspondence for most of the nuclei.

After obtaining affirmative results of the quality of the predictive power of the used mean-field Hamiltonian, we have carried out a systematic analysis of the existence and coexistence of certain particular exotic configurations which inspired significant experimental and theoretical interest in the literature, namely, super-oblate and toroidal configurations. The results showed an explicit influence of strongly oblate configurations in the region of mass A = (30 to 50). In addition, we have found that the hexadecapole deformation α_{40} strengthens the underlying oblate shell effects by presenting well-pronounced energy minima and leading to various forms of exotic shapes such as super-oblate and hyper-oblate, and shape coexistence.

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