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Executive Summary

The Nuclear Shell Model towards the Drip Lines

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The creation of model spaces that enable manageable configuration-interaction (CI) computations, from which one may comprehend and forecast the characteristics of low-lying states, serves as the foundation for the nuclear shell model. This decision is based on the finding that a small number of even-even nuclei can be regarded as having magic numbers for Z or N, as well as doubly magic numbers for a certain nucleon (Z, N). In the simplest approach, the magic number is connected to a ground state that, for the specified value of Z or N, has a closed-shell configuration. The phrase "magic number" was first used by Eugene Paul Wigner. From this starting point, one tries to make the Hamiltonian as close to the energy data as possible for a particular set of nuclei and states in the model space. Utilizing Singular Value Decomposition (SVD) is a practical method for accomplishing this. In various situations, one modifies TBME or TBME mixtures. The monopole, pairing, and quadrupole elements are the most significant. The evolution of the effective single-particle energies (ESPE) as one modifies the number of protons and neutrons is a crucial aspect of the universal Hamiltonian. These techniques apply two-body matrix elements to every nucleus in the model space and provide "universal" Hamiltonians to a single set of single-particle energies, maybe allowing for some smooth mass dependence.

The more ab initio techniques' shortcomings are covered by empirical adjustments to the effective Hamiltonian. Due to its practical analytical features, harmonic-oscillator bases are used for most ab initio calculations. The single-particle energy spectrum is compressed, the radial wavefunctions are expanded, and the continuum is explicitly more significant in the vicinity of the neutron drip lines.

The high-momentum tail seen in high-energy electron scattering investigations is linked to the short-ranged correlations. The long-range correlations originate from pairing correlations and particle-core coupling that go beyond what is included in the valence space. Another factor could be the approximations used in the reaction's dynamics in the sudden approximation.

They have concentrated on four "outposts" for the regions of 28O, 42Si, 60Ca, and 78Ni since they are the locations where future tests will have the biggest effects on our understanding of how nuclear structure evolves as one gets closer to the neutron drip line.

KEYWORDS

nuclear shell model; configuration-interaction method; magic numbers; proton drip line; neutron drip line; proton decay; neutron decay; collectivity; islands of inverson; effective charge