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Executive Summary

Probing Different Characteristics of Shell Evolution

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The evolution of the shell structure, often known as shell evolution, is one of the most significant findings from research on exotic nuclei (those from the stability). Sometimes, the evolution happens more abruptly than what the typical Woods-Saxon potential model predicts: some of the common neutron magic numbers. With the development of large-scale shell-model calculations, the influence of the monopole interaction on nuclear structure has been studied. Pf-shell nuclei are very successfully characterized by employing Kuo-Brown interactions with a few correctly adapted monopole matrix elements. The overall characteristics of the monopole interaction and its origin are one of the unresolved questions regarding shell evolution.

It was suggested in that the central and tensor forces are the main causes of shell evolution and that the two-body spin-orbit force plays a special role in the monopole matrix components between orbitals. The spin-tensor decomposition of an effective interaction fitted to the experimental data came to the same conclusion. The objective of the current work is to quantitatively assess how well such a straightforward scheme captures the evolution of shells.

The exact single-particle energy is provided by the spectroscopic factors' centroid. However, because their spectroscopic factors are too small to be determined, many energy levels cannot be found by the real experiment. Even though each of these undetected levels only makes a small difference to the centroid, there are a lot of them, so their combined impact is not insignificant. In this sense, the experimentally determined centroid of the spectroscopic factors cannot be free from ambiguity due to the low sensitivity of the experiment. Therefore, it is quite useful to compare between experiment and theory regarding how main peaks are dispersed to validate theoretical single-particle energies.

To assess how well the observed development can be explained by a straightforward monopole-based universal interaction, VMU, an almost exhaustive study of proton and neutron shell evolution for atomic mass numbers neutron-rich nuclei is done in this paper. The "reinversion" of single-particle level ordering between d3/2 and s1/2 because of the non-monotonic evolution of these level spacings is what leads to this alteration, as was previously mentioned. It is clear from this type of evolution's inability to be explained by one-body potential models that two-body forces predominate in the evolution of shells. In this instance, the central force is what is responsible for the non-monotonic evolution of K isotopes.

Source: [Physics]

KEYWORDS

Shell evolution; exotic nuclei; shell model; effective interaction; tensor force; spectroscopic factor; effective single-particle energy