RJPHY Research Journal of Physics

OPEN ACCESS

News & Comments

Developing Concept in Nuclear Structure Based on Shell Model

Alison Walter

The atomic nucleus occupies a special place in physics since it is an isolated object that contains a variety of quantum components. This paper reviews several recently developed ideas concerning the structure of atomic nuclei. Some of the new ideas were developed while researching unusual nuclei, namely by examining their shell structures and magic numbers. Later, it was discovered that the concepts obtained were not restricted to unusual nuclei. In this approach, the overall view of the nuclear shell structure has been updated following the initial trigger by unusual nuclei. Since Rainwater first raised the issue in the 1950s, the surface deformation caused by the sphere has become a crucial topic.

The fundamental query regarding the relationship between the single-particle degrees of freedom and the collective motion of nucleons is tied to the in-depth explanation of the collective band. Nuclear forces are required to link these two together. The answer to this question is still unclear. It is demonstrated that a key process for determining the neutron driplines is the interaction between the monopole interaction and the quadrupole deformation. Without diving into specifics, the goal of this work was to demonstrate the overall progression of fundamental concepts and associated findings. With one and a half HO major shells, the MCSM is now strong enough to replicate collective bands of heavy nuclei like 154Sm and 166Er.

First off, it has recently become possible to perform ab initio no-core Monte Carlo shell-model computations up to 12C and beyond. As an illustration, we can consider clustering in light nuclei, such as the Hoyle state, with correlations caused by nuclear forces. The shell model will yield a significant result if one goes with this approach. This covers definitions for terms like "decay," "knockout," etc. The search for fission dynamics and superheavy elements, with (nearly) full inclusion of the correlations owing to nuclear forces, is another significant frontier.

JOURNAL REFERENCE

Otsuka T. Emerging Concepts in Nuclear Structure Based on the Shell Model. Physics. 2022; 4(1):258-285.

KEYWORDS

nuclear structure; shell model; exotic nuclei; shell evolution; type-II shell evolution; nuclear shape; self-organization; dripline; monopole interaction; monopole-quadrupole interplay