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Symmetries as a framework for understanding the emergence of nuclear collective behavior

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Ab initio nuclear theory, for which the only input is the inter-nucleon interaction, can provide a deeper understanding of the origins of nuclear collective behavior. In no-core shell model (NCSM) calculations of p-shell nuclei, rotational bands with vastly different structure and deformation appear within the same nucleus (shape coexistence). To gain insight into the underlying symmetries and correlations which give rise to this emergent collective behavior, we decompose the calculated wave functions by symmetry content. In particular, we consider the symmetries associated with Elliott's SU(3) rotational model and its multishell extension Sp(3,R), which further incorporates giant monopole and quadrupole resonance degrees of freedom. Through the decompositions, we demonstrate that these symmetries provide a natural framework for understanding the emergence of rotational behvior in the p-shell and discuss how these symmetries can also be used to guide investigation of collective behavior in heavier nuclei.

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