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Quasi-SU(3) coupling induced shape evolution in shell-model calculations for heavy nuclei

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Shapes and shape evolution have long been a discussion focus in nuclear physics. The study of this topic requires extension of shell model calculation to heavy mass regions. There, one faces two major problems: how to incorporate a large model space in the calculation and how to interpret the results with the vast shell-model output. A promising tool is the Hartree-Fock-Bogolyubov plus generator coordinate method (HFB+GCM), in which the angular-momentum-projected GCM with quadrupole-constrained Hartree-Fock basis states is introduced into shell-model calculations. To discuss physics from shell-model calculations, Zuker et al. [1,2] proposed that the backbone for emergence of large collectivity is the quadrupole correlation in the key partner orbits with ⍰ j=2, (1g9/2, 2d5/2) separated by the N = 50 shell gap, for their examples in the mass-60 region. The present talk extends this idea, named quasi-SU(3) coupling [1,2], to heavier mass regions. We have shown that by moving one major shell up, one can expect a similar quasi-SU(3) coupling of (1h11/2, 2f7/2) across the N = 82 shell gap [3], which plays an important role in the sudden increase of quadrupole collectivity found around N = 70 in the Nd isotopes. By moving two major shells up [4], the quasi-SU(3) coupling of (1i13/2, 2g9/2) across the N = 126 shell gap is responsible for the sudden increase of quadrupole collectivity found around N = 104 in the Po isotopes. In Ref. [5], the quasi-SU(3) idea has been extended to an isovector type to describe the triple enhancement in B(E2) around N=Z=40 isotopes, where we interpreted the emerged collectivity as caused coherently by the n-n, p-p, and n-p components of the quasi-SU(3) couplings. Nuclei with A~130 are typically transitional, where different shapes and shape evolution are classified in the Casten triangle [6] based on the algebraic interacting boson model [7]. We found [8] that by considering two quasi-SU(3) couplings, (1g9/2, 2d5/2) and (1h11/2, 2f7/2), one can understand the shape evolution in the extended Casten triangle. The quasi-SU(3) coupling in (1g9/2, 2d5/2) is found to be the main driving force toward the gamma softness of the O(6) limit, while the one in (1h11/2, 2f7/2) is responsible for changing the deformed shapes from oblate to prolate.

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