SHELL EVOLUTION, SHAPE TRANSITION AND SHAPE COEXISTENCE WITH REALISTIC NUCLEAR FORCES

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We will overview recent developments (i) on the structure of neutron-rich exotic nuclei based on modern nuclear forces and (ii) on the shape transition/coexistence driven by the shell evolution. The type I shell evolution, which is the change of shell structure within a chain of isotopes, will be discussed in terms of the effective interaction derived from the N3LO chiral-EFT two-body and the Fujita-Miyazawa three-body forces. The newly developed EKK method enables us to derive an effective interaction for two major shells, *e.g.*, sd+pf. Z=10-14 (Ne-Si) isotopes around the island of inversion will be described focusing on intruder mixture in transitional nuclei. Another example is Ca-Ni isotopes with the pf-sdg shells, clarifying magicity at ^{52,54}Ca and ^{68,78}Ni as well as strong deformation in ^{62,64}Cr.

The shape transition and shape coexistence will be discussed by using the state-of-the-art large-scale Monte-Carlo shell-model, describing spherical and extremely deformed states on the same footing. The shape coexistence in exotic Ni will be explained in terms of type II shell evolution where the shell structure is reorganized due to multiple particle-hole excitations for particular orbits, resulting in strongly deformed states at very low energy. This idea is extended to $^{90\text{-}110}$Zr, reproducing the sudden drop of the 2^+ level at ^{100}Zr, as an evidence of the first-order quantum phase transition. Here, type II shell evolution is driven cooperatively by the monopole components of tensor and central forces. They weaken the resistance against deformation. This mechanism, called Dual Quantum Liquid, can be relevant superdeformation and fission.