Large-scale shell-model studies for exotic nuclei: probing shell evolution

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While recent advancement in supercomputing has made it possible to perform *ab initio* nuclear studies without phenomenological assumptions, their applicability is still limited to very light nuclei and some medium-heavy nuclei near closed shells. For a systematic study of heavier nuclei in this direction, the shell model is a possible choice. The effective interaction for the shell-model calculation can be constructed in a fully microscopic way, but such microscopic interactions are not very successful in a systematic description of nuclei from stable to exotic nuclei. In particular, so-called monopole interaction, which is responsible for the evolution of shell structure, is rather ambiguous in microscopic theories, and is a key to high predictive power. Shell evolution is also one of the most attracting subjects in the physics of exotic nuclei.

In this talk, we give an overview of current understanding of shell evolution due to the effective interaction. Although our approach is not fully based on microscopic theories, it is comprehensive and will serve as a good guide to microscopic theories. Large-scale shell-model calculation is also an important ingredient for probing shell evolution because pure single-particle(-like) states are rarely observed. We also present our computational tools for large-scale shell-model calculations: the Monte Carlo shell model (MCSM) calculation [1] and the conventional diagonalization method using the codes KSHELL [2] and MSHELL64 [3]. We show some recent examples ranging from light to medium-heavy nuclei, including the appearance and disappearance of the N=28 and 34 magic numbers [4,5], shape coexistence in exotic Ni isotopes due to configuration-dependent shell structure [6], and unusual evolution of the proton single-particle-like states along the Sn isotope chain [7].

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