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Evolution of shell and nuclear structure in the neutron rich region[1]

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Evolution of shell structure in exotic nuclei has attracted significant interest both theoretically and experimentally. Recently, roles of the nuclear force in the evolution of shell structure have been clarified. Among them the tensor force has a unique feature that it reduces strongly the spin-orbit splitting at $j - j$ closed nuclei. This accounts for the disappearance of the $N = 20$ magic number and appearance of a new $N = 16$ magic number in exotic nuclei. Hence, it is of great interest whether an effective interaction based on the picture can describe a wide range of the nuclear chart in a natural way. In this talk, I will present how the shell evolution occurs far from stability and how its effect emerges in a nucleus as a many-body system based on the shell model. In particular, the structure in the $N = 28$ region with a newly developed effective interaction is focused. With a natural choice of the tensor force and the central force, some exotic properties for $N = 28$ nuclei are described such as a large deformation in ^{42}Si and quenching of the proton's spin-orbit splitting at ^{48}Ca probed by the distribution of spectroscopic factors. The present interaction predicts another interesting phenomenon beyond $N = 28$: the shell gap does not change monotonically as a potential picture gives. The way of constructing the interaction is simple but highly predictive. By using that, the evolution of shell structure in heavier regions will also be discussed.

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