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New Aspects of Nuclear Structure

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In recent years, more exotic nuclei have been studied, with unexpected features and their theoretical explanations. I shall sketch some of them. Over the past ten years, our understanding and treatment of the nuclear forces, two-, three- and n-body, have become deeper and more precise, in a closer way with QCD. At the same time, the effects of nuclear force on exotic nuclei have been clarified better. The conventional pictures of the nuclear shells, magic numbers, and correlations have been modified considerably. For instance, the shell structure of exotic nuclei are different from the one for stable nuclei due to some specific components of the nuclear force, e.g., the tensor force. The modern theory of the nuclear forces supports this picture, and experiments done in the past several years indeed suggest such changes from stable to exotic nuclei. The most striking recent finding is the effect of three-body force. The three-body force has been shown, by ab initio calculations, to increase binding energies. While this is correct, Fijita- Miyazawa three-body force coming from Delta excitation produces characteristic repulsive effects between excess neutrons, affecting binding and shell structure. A good example is exotic oxygen isotopes: the dripline is unusually closer to the stability line, and exotic magic numbers N=14 and 16 have been established experimentally. The underlying origin of these anomalies have remained a puzzle, but we can now solve it in terms of the three-body force. While the mechanism is understood very intuitively, the EFT plays a significant role in the evaluation of three-body force effects. These effects are a general and robust one. Thus, our view over exotic nuclei are being changed, and the interplay between nuclear structure physics and hadron physics should become more crucial in this frontier.