ROLES OF PAIRING INTERACTIONS IN THE FORMATION OF LOW- AND HIGH-ENERGY GAMOW-TELLER EXCITATIONS

Yoshitaka Fujita, Research Center for Nuclear Physics & Department Physics, Osaka University, Toyonaka, Osaka, Japan

Protons and neutrons can form strongly correlated pairs [1]. These nuclear correlations are treated as effective residual interactions (ERIs). We see that giant resonances (GRs) are the examples of collective excitations caused by various ERIs. Depending on the attractive or repulsive natures of active ERIs, GRs can be pulled down or pushed up in their excitation energies [2]. Note that nucleons have a spin-degree of freedom and also an isospin-degree of freedom. Thus, nuclear excitations and also ERIs can have the isoscalar (IS) or isovector (IV) characters.

In this respect, Gamow-Teller (GT) excitations that are caused by a simple $\sigma\tau$ operator (spin-flip and isospin-flip operator) are unique in atomic nuclei consisting of two fermions. In addition, the transitions are among the same *j* orbits or the spin-orbit partners, and thus the number of configurations involved is rather small. Therefore, they can largely reflect the specific structures of individual nuclei as well as the involvements of ERIs [3].

The GT excitations were studied for the mass number A=42, 46, 50, and 54 *f*-shell nuclei in (3He, t) charge-exchange reactions. In the 42Ca → 42Sc reaction, most of the GT strength was concentrated in the lowest $J\pi = 1+$ state at 0.6 MeV, suggesting the existence of a low-energy GT collective excitation. As mass A increased, the structure of GT resonance (GTR), i.e., a high-energy GT collective excitation, developed in the 6-11 MeV region. In the 54Fe → 54Co reaction, the GTR mainly carried the GT strength.

We found that the formation of low- and high-energy GT collective excitations are attributed to the contribution of the attractive IS and repulsive IV ERIs, respectively, that are active in particle-particle (p-p) and particle-hole (p-h) configurations in nuclei [4].

REFERENCES

[1] "Fifty Years of Nuclear BCS, Pairing in Finite Systems," edited by R.A. Broglia and V. Zelevinsky (World Scientific, Singapore, 2013).

[2] "Giant Resonances," by M.N. Harakeh, A. van der Woude, Oxford Studies in Nucl. Phys. 24, (Oxford University Press, Oxford, 2001).

[3] Y. Fujita, B. Rubio, and W. Gelletly, Prog. in Part. and Nucl. Phys. 66, 549 (2011).

[4] Y. Fujita et al., Phys. Rev. Lett. 112, 112502 (2014).