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np spin-correlation in the ground state studied by the sum-rules of the spin-M1 transition matrix elements and implications to the IS np pairing correlation

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How are nucleons correlated in the ground state of atomic nuclei? It is one of fundamental questions to understand the strongly correlated nuclear system. Amongst many correlations, the correlation between a neutron and a proton, more specifically the isoscalar (IS) np pairing correlation, is thought to play a minor role in mean-field models while the isovector (IV) paring correlations are well descried by the quasi-particle description. However, the IS np paring is obviously stronger in the ground state of light nuclei, e.g. a deuteron or 6Li. How does the IS paring correlation manifest itself in heavier nuclei? We have obtained an evidence of np spin-correlation, that naturally emerges from the np pairing correlation, in sd-shell nuclei. The np spin-correlation function (npSCF) is proportional to the difference of the non energy-weighted sum-rule values of the IS and IV spin-M1 squared transition matrix elements. The npSCP takes a value of +1/4(-3/4) for the full spin-alignment (anti-alignment) that emerges from the IS (IV) np pairing in s-wave. The observed npSCFs showed a positive value of +0.1 for all the measured even-even self-conjugated nuclei in the sd-shell [1]. The result shows stronger IS np-pairing than the IV np-pairing.

How can one understand the result with theoretical models? The shell-model with the USD interaction does not reproduce the positive npSCFs. Similar result was obtained for a large-scale shell model calculation [2]. However the non-core shell-model predictions hint the positive npSCFs [1] that implies the importance of the core-polarization effect. The positive npSCFs are also predicted for 4He by ab initio calculations employing modern NN interactions [1,3]. Recent phenomenological study using shell-model wave functions could reproduce the positive npSCFs by introducing an enhanced IS spin-triplet pairing interaction and the Delta-hole coupling effect [4].

In this seminar, I will discuss in detail the experimental finding and its interpretations as well as possible future extensions to other excited states.

[1] H. Matsubara et al., Phys. Rev. Lett. [2] N. Shimizu, Y. Utsuno, and N. Tsunoda, private communication [3] W. Horiuchi et al., Phys. Rev. C 87, 034001 (2013).
[4] H. Sagawa et al., Phys. Rev. C 94, 041303(R).

＊ The talk will be given in English language..

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RIBF Hall (rm.201), RIBF bldg., RIKEN

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