Contribution ID: **13** Type: **not specified**

Role of tensor force in light nuclei with tensor optimized shell model

Wednesday, 2 November 2011 11:00 (30 minutes)

In the bare nucleon-nucleon force, the tensor force coming from the pion exchange explains the large amount of the nuclear binding energies. In the nuclear wave function, the 2p2h excitation involving high momentum component is essential to describe the strong tensor correlation. In this study, we investigate the role of the tensor force in the light nuclei.

We employ a shell model type prescription, in which the 2p2h configurations are fully optimized into the high momentum states. We call this method as "tensor-optimized shell model" (TOSM). We treat the short-range repulsion using the unitary correlation operator method (UCOM). Using "TOSM+UCOM" as the basis states, we describe the nucleus from bare nucleon-nucleon interaction [1].
The TOSM also becomes the foundation of the tensor-optimized few body model (TOFM) by Horii et al. and the extended Brueckner mean field theory by Ogawa et al.

1. We show the results of neutron-rich He and Li isotopes using the Argonne interaction [2]. In 4He ,the major 2p2h state is the proton-neutron pair excitation induced by the tensor force. This specific 2p2h excitation causes the Pauli-blocking effect in the excited states of 5He to 8He, which generates the LS splitting energies in those nuclei.
2. We discuss the origin of the neutron halo in 11Li [3]. The halo structure in 11Li indicates a large s-wave component of neutrons in spite of the magic number N=8. We solved this N=8 shell problem by treating the tensor correlation with the help of TOSM. Based on the three-body model with the 9Li core described in TOSM, the Pauli-blocking from the tensor correlation produces the energy loss in the p-shell closed state of 11Li. As a result, the magic number was naturally broken in 11Li and the halo structure is explained.

[1] T. Myo, H. Toki, K. Ikeda, Prog. Theor. Phys. 121 (2009) 511.
[2] T. Myo, A. Umeya, H. Toki, K. Ikeda, Phys. Rev. C84 (2011) 034315.
[3] T. Myo, K. Kato, H. Toki and K. Ikeda, Phys. Rev. C76 (2007) 024305.

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