Role of the explicit tensor correlation in neutron halo nuclei

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The tensor force is an essential component in nuclear force and plays an important role in the nuclear structure. The exact calculations clarified that the contribution of the tensor force is comparable to the central case in the light nuclei. It is important to understand the effect of the tensor force on the nuclear structure. In this study, we investigate the role of the tensor correlation in the neutron-halo nuclei, such as ^{6}He and ^{11}Li, and their neighboring nuclei.

Especially, the biggest puzzle in ^{11}Li is the large s-wave component for the halo neutrons, which means that the shell gap at $N = 8$ disappears. However, no theory can explain this disappearance and all the theoretical works for ^{11}Li and neighboring nuclei had to accept that the $1s_{1/2}$ state is brought down to the $0p_{1/2}$ state without knowing its reason. It is therefore the challenge to solve the $N = 8$ shell gap problem in neutron-rich region. In this study, this problem is worked out by considering the tensor correlation explicitly.

We start with the extended three-body model of core+n+n where the core nucleus is described by the tensor-optimized shell model[1, 2] and the valence two neutrons are described by the Gaussian expansion method. We describe the core's wave function within many $2p2h$ excitations to obtain the convergence of the bare tensor force contribution explicitly. It is found that the 0^- type excitation of the $(0s_{1/2})^{-2}_{\pi\nu}(0p_{1/2})^{2}_{\pi\nu}$ component is large and important to describe the tensor correlation. This reflects the pion nature of the tensor force.

From the specified excitation of the tensor correlation, the Pauli blocking is considered in ^{11}Li as shown in Fig. 1. This blocking is expected to enhance the $(1s)^2$ component in ^{11}Li. By considering two blockings from the tensor and pairing correlations, simultaneously, we naturally reproduce the large $(1s)^2$ component in ^{11}Li shown in Fig. 2, which explains the halo structure with the large matter radius as 3.41 fm. Our results also reproduce recently observed charge radius and Coulomb breakup strengths[3]. Simultaneously, the inversion phenomena of $1s$-$0p$ states in ^{10}Li is explained.

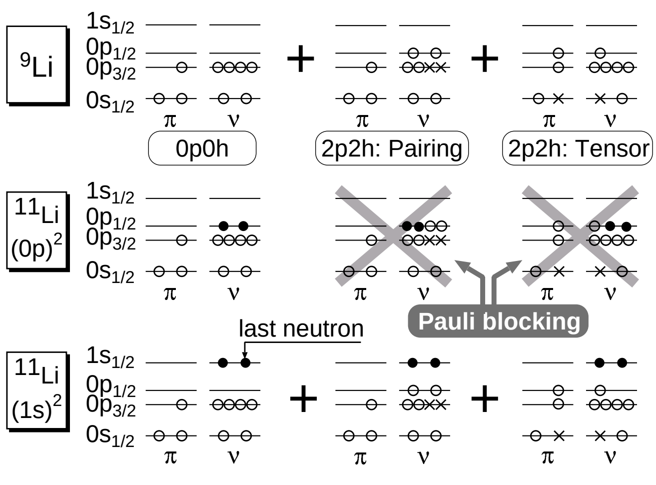

Figure 1: Pauli-blocking effect in ^{11}Li.

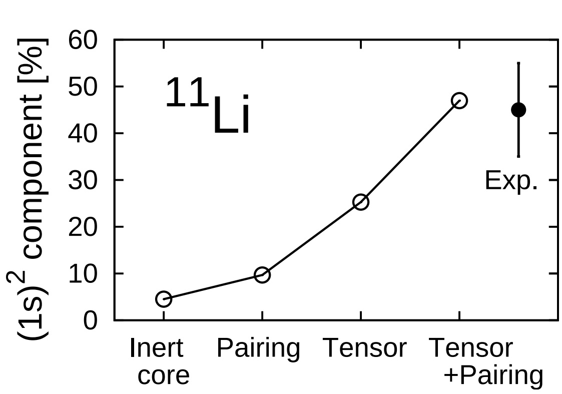

Figure 2: $(1s)^2$ probability in ^{11}Li.

References

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