Contribution ID: **135** Type: **Oral**

Overlap integrals in core + n + n systems

Thursday, 23 September 2021 10:55 (20 minutes)

Di-neutron correlations are extensively explored in recent experiments, and the enhancement of the spatial localization of the pair of the neutrons (n) has been confirmed at the nuclear surface in the light neutron-excess systems, such as ^{11}Li and ^{19}B. The di-neutron correlations are also investigated theoretically by employing the three-body model with core + n + n. The analysis of the di-neutron correlation gives an important key to elucidate the intrinsic structure of neutron stars. If we consider the three-body system of core plus two neutrons, the spatial localization of two neutrons corresponds to the formation of "di-neutron cluster" around the core nucleus.

On the other hand, the valence neutrons usually perform the independent particle motion around the core nucleus, and the ground state of the normal nucleus is explained by the so-called the nuclear shell model. The shell model configuration and the di-neutron one seem to be very different structure intuitively but these two configurations are non-orthogonal, and there is a finite amplitude of the di-neutron cluster component even if the pure shell model state is realized. Thus, in order to understand the feature of the di-neutron cluster more deeply, it is important to evaluate the overlap integral of the di-neutron cluster state and the shell model state, which is a measure of the non-orthogonal amplitude of these two different states.

We have proposed a new formula to evaluate the overlap integral of the cluster and shell-model configurations, and the formula is applied to the core + n + n systems. In this report, we will report the systematic feature of the overlap integrals of the di-neutron cluster state (core + 2n) and the shell model state (core + n + n) with a variation of the core mass number. In particular, we will discuss the enhancements of the overlap integral in connection to the single particle orbits of the valence two neutrons in the shell model states.

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Session Classification: Session 8

Track Classification: Nuclear Structure, Reactions and Dynamics