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Visualization of nuclear cluster correlation with microscopic wave function

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In general, the quantum many-body wave function obtained by theoretical calculation contains an enormous amount of information about many-body correlation. However, theoretical analyses in nuclear physics are mainly performed for quantities such as one- and two-body densities, which are obtained after integrating out most of the information in a many-body wave function.

On the other hand, in the field of quantum chemistry, methods have been developed to visualize the information on the correlation of all electrons and applied to the structure study of molecular systems[1]. We are now attempting to apply such a method to nuclear systems. As the first step, we start with finding the most probable arrangement of nucleon coordinates, i.e., calculating the set of position and spin coordinates that maximizes the square of the many-body wave function.

In this talk, we apply this method to Hartree-Fock and Hartree-Fock+BCS wave functions of p-shell and sd-shell nuclei. We found some alpha-cluster-like correlations out of the wave functions obtained without any assumption of cluster structure. We also discuss the effects of pairing correlation on the cluster structure by comparing the results between HF and HF+BCS.

[1] Yu Liu, Terry J. Frankcombe, and Timothy W. Schmidt, Phys. Chem. Chem. Phys. 18, 13385 (2016).

Experimental nuclear physics

Theoretical nuclear physics

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Primary authors: MATSUMOTO, Moemi (Tohoku University); TANIMURA, Yusuke (Tohoku University)

Presenter: MATSUMOTO, Moemi (Tohoku University)

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