Dineutron formation and breaking in ^{8}He

Fumiharu Kobayashi and Yoshiko Kanada-En'yo

Department of Physics, Kyoto University, Kyoto 606-8502, Japan

Neutron-rich nuclei have been investigated eagerly so far, and many interesting phenomena are suggested. The dineutron correlation is the one of the most attractive phenomena in the physics of neutron-rich nuclei. A dineutron is a compact spin-singlet pair of two neutrons. Two neutrons are unbound in free space but it is theoretically suggested that they have the strong spatial correlation to be a compact dineutron in the low-density region of nuclear matter [1]. Also in neutron-rich nuclei, the strong dineutron correlation is suggested to be realized in the neutron-halo and -skin [2]. Since two neutrons are unbound, the strength of the dineutron correlation can change largely and readily depending on the nuclear density or structure. Therefore, it is very interesting and challenging to investigate the dineutron correlation in various nuclei systematically in order to make clear the universal properties of the dineutron correlation in finite nuclei. For that aim, we constructed a framework "the dineutron condensate (DC) wave function", which can be applied to most of light neutron-rich nuclei [3]. A compact dineutron is considered as a kind of cluster, though it is soft and fragile. Thus, we also expect that the understanding of the dineutron formation would lead to the more sophisticated understanding of the general cluster formation.

We apply the DC wave function to ^{8}He, composed of an α and four valence neutrons forming a neutron-skin, and investigate the dineutron correlation there. In the ground state, where valence neutrons are moderately bound, the $(0p_{3/2})^4$ shell-model component and the component of one developed dineutron compete each other and both of them are important to describe its structure. On the other hand, the one of two developed dineutrons is minor compared to the others. It is because the spin-orbit attraction from the α core tends to dissociate the spin-singlet dineutrons, so two dineutrons are unlikely to be formed and developed simultaneously. In addition to the investigation of the ground state, we also investigate the excited 0^+ state of ^{8}He and suggest the possibility of the two-dineutron condensate state, which means that two dineutrons behave as two bosons and occupy the lowest S-wave. Such a condensate state is characterized by the gas-like structure of one α and two dineutron clusters which are correlating weakly each other and are expanded largely. We find that the sufficient attraction between the α and the valence neutrons is essential for the formation of the dineutron clusters and its condensation.

In this presentation, we will show the results of the investigation on the structures of ^{8}He from the viewpoint of the dineutron correlation, and we will discuss the importance of the dineutron correlation in the ground and excited 0^+ states in ^{8}He.

[1] M. Matsuo, Phys. Rev. C **73**, 044309 (2006)

[2] K. Hagino, H. Sagawa, J. Carbonell and P. Schuck, Phys. Rev. Lett. **99**, 022506 (2007)

[3] F. Kobayashi and Y. Kanada-En'yo, Prog. Theor. Phys. **126**, 457 (2011)

E-mail: f-kobayashi@ruby.scphys.kyoto-u.ac.jp