Search for the α-condensed state by measuring the inelastic resonance scattering ^{12}C(^{12}C,^{12}C[0_2^+])^{12}C[0_2^+]

K. Sakanashi[1], T. Kawabata[1], Y. Kanada-En'yo[2], K. Yoshida[2], K. Inaba[2], T. Doi[2], T. Furuno[3], A. Sakaue[2], Y. Fujikawa[2], S. Okamoto[2], K. Katayama[2], Y. Arakawa[2], S. Enyo[2], R. Kongo[2], S. Takagi[2], Y. Hijikata[2], R. Matsumoto[2], T. Mikami[2], and K. Miyazato[2]

[1]Department of Physics, Osaka University, Toyonaka, Osaka 505-0043, Japan
[2]Department of Physics, Kyoto University, Kyoto 606-8502, Japan
[3]Research Center for Nuclear Physics, Osaka University, Ibaraki, Osaka 567-0047, Japan

Alpha particle clustering is an important phenomenon in nuclear physics, especially for light nuclei. It is known that the α cluster structure appears near an α-decay threshold energy due to a strong correlation of four nucleons and relatively weak interaction between α clusters. For example, the 0_2^+ state in ^{12}C, which locates at an excitation energy higher than the 3α-decay threshold by 0.39 MeV, has a spatially developed 3α structure. It is pointed out that this 0_2^+ state is the α condensed state in which all α clusters are condensed to the lowest energy orbit [1]. Generally, nuclear density in most nuclei is saturated around the normal density, but this α condensed state is less dense than normal nuclei [2]. Therefore, the α condensed states are of great interest as a new form of nuclear structure. It is a very natural question whether such an α-condensed state universally exists in the heavier self-conjugate $A = 4N$ nuclei or not. According to a theoretical examination by Yamada et al., the α condensed states exist metastably up to ^{40}Ca ($N \leq 10$) [3]. Since all of the α clusters in the α condensed states occupy the same $0s$ orbit, overlaps between the α condensed states in different nuclei are quite large. Thus, the α condensed states prefer to decay into the lighter α condensed states.

In this study, we searched for a 6α-condensed state which is theoretically predicted at an excitation energy of $E_x = 33.4$ MeV. We populated excited states at $E_x = 32.1$–38.9 MeV in ^{24}Mg (^{24}Mg*) by the ^{12}C+^{12}C resonance scattering using a ^{12}C beam at $E_{beam} = 36.5$–56.7 MeV, and detected 6α particles emitted from the ^{24}Mg* $\rightarrow$ ^{12}C(0_2^+) + ^{12}C(0_2^+) $\rightarrow$ 6α process.

In this talk, we will report the details about the experiment and the result.

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