Measurement of the α-decay from the cluster-state at $E_x \sim 10.3$ MeV in ^{12}C

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The ^{12}C nucleus has both structures of the α cluster and of the shell-model-like. In the α cluster model, the 0_2^+ state at E_x=7.65 MeV and theoretical 2_2^+ state are thought to be 3α-molecular states [1]. In the recent theoretical interpretation by Tohsaki and Horiuchi *et al.* [2, 3], this 0_2^+ state can be interpreted as an α-condensation-like state with a new α cluster wave function. According to the 3-α RGM calculation by Kamimura [1], the 2_2^+ state should be a 2^+ member of a β band beginning the 7.654 MeV 0_2^+ state. In the calculation of the α-cluster model for ^{12}C, treat as the existence of the 2_2^+ state, However, this 2_2^+ state has not been exactly identified by the experimental studies. In Ref. [4], this state has been tentatively assigned to be 0^+.

In our previous ^{12}C(α,α') experiment, we evidenced the existence of this 2_2^+ state at $E_x\sim$10 MeV buried under the broad 0_3^+ state by the multipole decomposition analysis [5]. In this experiment, we measured decay-α particles from $E_x\sim$10 MeV states on the ^{12}C(α,α'+α'') reaction in order to study the internal structure of these $E_x\sim$10 MeV states and also to confirm the J^π from the angular correlation of the decay-α particles.

The measurement was performed using the GRAND RAIDEN spectrometer (GR) and the 8-SSD arrays with 386 MeV α particles. The setting angles of GR were 0° and 4°, where the L=0 and L=2 cross sections are maximum, respectively. SSDs were mounted at backward angles from 95° to 165°at intervals of 10°. The solid angle of each SSD was 5.96 msr. The thickness was 500 μm with which decay-α particles up to 35 MeV stopped in the SSD.

Figure 1 shows two-dimensional scatter plot of coincidece events for decay-α particles and the energy spectrum of the ^{12}C(α,α') reaction at 0°. There are two locus for α decay to the gound-state of ^{8}Be and to the first 2^+ state of ^{8}Be, though the first 2^+ state of ^{8}Be is obscure due to the broad width of the state. Figure 2 shows ^{12}C(α,α') spectra in coincidence with the α decay to the ground state of ^{8}Be (a), and to the first 2^+ state of ^{8}Be (b). In the region lower than E_x=10 MeV, the E_xsim10 MeV state seems to decay mainly to the ground state of ^{8}Be. On the other hand, in the region upper than 10 MeV, it seems to decay mainly to the first 2^+ state of ^{8}Be. Figures 3 and 4 show angular correlations for the α decay of ^{12}C for the $E_x\sim$10 MeV region. Detail analysis is now in progress.

References

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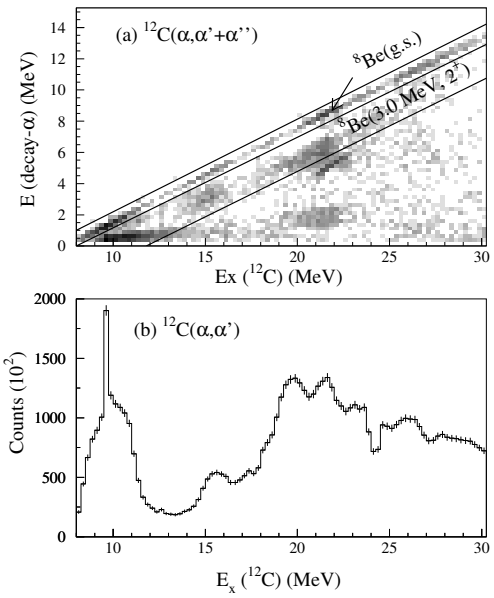

Figure 1: (a) Two-dimensional scatter plot of coincidence events for α particles. (b) Energy spectrum of the ^{12}C(α,α') reaction at 0°.

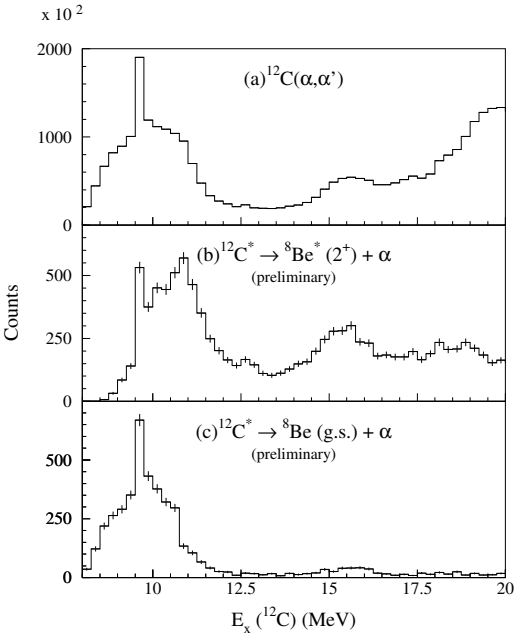

Figure 2: ^{12}C(α,α') spectra in coincidence with decay-α particles.

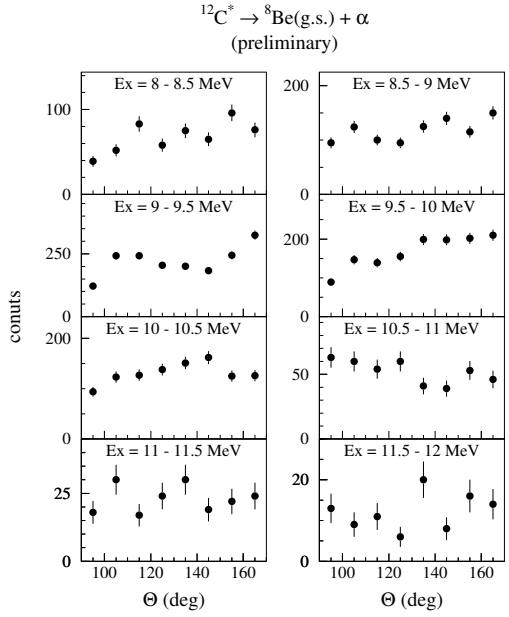

Figure 3: Angular correlation for the α-decay of ^{12}C* to the ground state of the ^{8}Be.

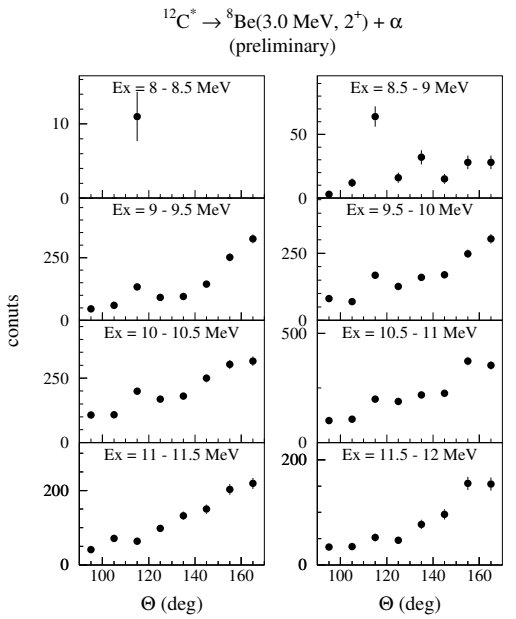

Figure 4: Angular correlation for the α-decay of ^{12}C* to the first 2$^+$ state of the ^{8}Be.