Di-trinucleon cluster structures in ^{6}He and ^{6}Be

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In recent years, a new light has been casted on the issue of the trinucleon clustering in A=6 nuclei [1, 2]. Akimune *et al.* found a resonance with the t+t structure in ^{6}He at E_x=18.0±0.5 MeV with a width of 7.7±1.0 MeV via the ^{6}Li(^{7}Li,^{7}Be) reaction at 455 MeV [1]. Though the spin assignment of the resonance was not obtained in their experiment, the resonance was suggested to be the ^3P state from the comparison with the *LS*-coupling cluster model [3].

Most recently, Nakayama *et al.* observed a broad resonance with the t+^{3}He structure in ^{6}Li at E_x=21 MeV with a width of 12 MeV via the ^{7}Li(^{3}He,α) reaction at 450 MeV [2]. Based on the measured angular correlation of the decaying t and ^{3}He particles from the resonance, they concluded that the resonance consists of the P doublet, namely, the ^1P (T=0) state at E_x=18.0±0.5 MeV and ^3P (T=1) state at E_x=22±1 MeV [2]. The observed excitation energies of the ^1P and ^3P states in both experiments were in contradiction to the theoretical results [4, 5].

In the present work, we investigated the P states in ^{6}He and ^{6}Be. In ^{6}He, we remeasured the ^{6}Li(^{7}Li,^{7}Be) reaction to assign the angular momentum of the resonance at E_x=18 MeV observed in the previous study [1]. In ^{6}Be, no experimental information on the ^3P state was reported. The ^3P state should also exist at E_x∼18 MeV as a counter part of the resonances in the ^{6}He.

The experiments were carried out at RCNP by using the 450-MeV ^{3}He and 455-MeV ^{7}Li beams from the ring cyclotron. Figures 1(a)-(c) show spectra measured in the ^{6}Li(^{3}He,t,^{3}He) reaction. The analysis of the singles spectra has been published elsewhere [6]. In the scatter plot of coincidence events for the the ^{6}Li(^{3}He,t,^{3}He) reaction, as shown in Fig. 1(b), a locus along the kinematical threshold for the ^{3}He+^{3}He decay is clearly seen. Fig. 1(c) shows a spectrum gated along the locus for the ^{3}He+^{3}He decay. A resonance was observed at E_x=18.0±1.2 with a FWHM of 9.2±1.3 MeV. A similar resonance was also observed in ^{6}He at E_x=18.0±1.0 with a FWHM of 9.5±1.0 MeV via the ^{6}Li(^{7}Li,^{7}Be,t) reaction. These values are in a good agreement with those obtained in the previous work [1].

From the analysis using the Breit-Wigner's one-level formula, the branching ratios for the ^{3}He and t decays in ^{6}Be and ^{6}He, respectively, were derived to be 70∼80%. These values are larger than the calculated branching ratio in the statistical model by more than two orders, suggesting that the 18-MeV resonances are due to the trinucleon clustering structures. Since the angular correlations of decaying ^{3}He and t from the resonances at E_x=18 MeV in ^{6}Be and ^{6}He, respectively, showed a dominant contribution from an L=1, we assigned the 18-MeV

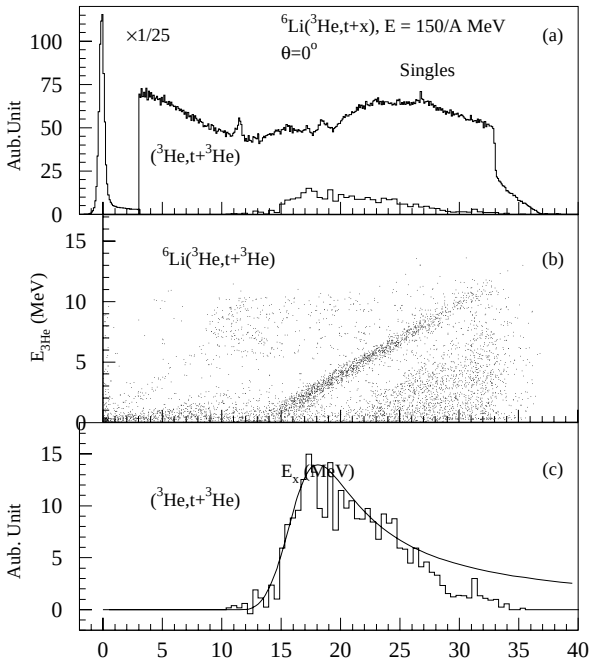

Figure 1: (a) A singles spectrum measured in the ^{6}Li(^{3}He,t) reaction at θ_L=0° and at the incident energy of 450 MeV. (b) A two-dimensinal scatter plot of coincidence events in the ^{6}Li(^{3}He,t,^{3}He) reaction. (c) A gated spectrum in the ^{6}Li(^{3}He,t,^{3}He) reaction. A solid curve shows a fit with the Breit-Wigner formula. The horizontal scale is the excitation energy in ^{6}Be in unit of MeV.

resonances in both ^{6}Be and ^{6}He to the ^3P states. Thus, the complete set of the ^1P and ^3P states were experimentally establised in A=6 isobar system, for the first time. Detail of the work will be published elsewhere.

These experiments were performed at the Research Center for Nuclear Physics, Osaka University under the Program Nos. E172, E184, and E190.

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