s-Hole State in ^{5}He and its d-t Cluster Structure

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The one-nucleon knockout reaction with an intermediate energy proton is suitable to investigate the structure of hole-states especially in light nuclei because the reaction mechanism is predominantly direct one-step process and the good condition for the kinematics can be selected for each excitation of the hole state [1]. For light p-shell nuclei like Li isotopes, this reaction may reveal the relative importance of the single particle aspects and clustering aspects. In fact, our previous study for the ^{7}Li(p,2p) reaction has pined down that the s-hole state in ^{6}He has di-triton cluster structure [2]. Since the ^{6}Li ground state has been viewed as an α+d cluster structure, it is also interesting to find out the relation between the s-hole state in ^{5}He and a d+t cluster structure.

The experiment (E250) for the ^{6}Li(p,2p) reaction was performed at RCNP by using a 392 MeV proton beam. The experimental setup was similar to the previous E204 experiment. Two outgoing protons were measured with the Grand Raiden (GR) and the large acceptance spectrometer (LAS). Charged decay particles from the hole states in ^{5}He were measured with fifteen Si surface-barrier detectors placed at backward angles in coincidence with the quasifree $(p, 2p)$ reactions.

Excitation energy spectrum of the hole-states obtained by the ^{6}Li$(p, 2p)^{5}$He reaction is shown in Fig. 1(a). Even the ground state of ^{5}He is above the α+n threshold and unbound. A bump corresponding to the s-hole state is strongly excited around 17 MeV. Two-dimensional plot with decay charged particles is shown in Figs. 1(b). This clearly shows that the ^{5}He(s-hole) state has two components: one is a sharp 16.8 MeV peak which considerably decays to the α+n channel and the other is a broad bump starting from the d+t threshold which almost decays to the d+t channel. The first peak may be regarded as the famous $\frac{3}{2}^{+}$ resonance, which is known for its role in nucleosynthesis, in energy-producing fusion, and in 14 MeV neutron generator [3].

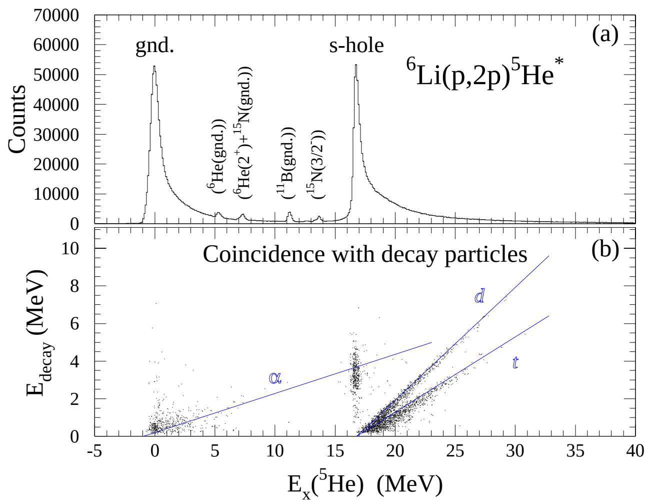

Figure 1: (a) Excitation spectrum of ^{5}He produced by the ^{6}Li$(p, 2p)^{5}$He* reaction at $E_p = 392$ MeV. (b) Two-dimensional plot of the energies of the decay particles versus the excitation energy of ^{5}He. The loci corresponding to α+n and d+t two-body decays are indicated.

The detailed analysis including the branching ratio of each channel, decay angular correlations, etc., is still in progress.

References

[1] M. Yosoi et al., Phys. Lett. B **551** 255 (2003);
M. Yosoi et al., Phys. Atomic Nuclei **67** 1810 (2004).

[2] Y. Nakatsugawa et al., in this Annual Report.

[3] G.M. Hale, R.E. Brown, and N. Jarmie, Phys. Rev. Lett. **59** 763 (1987).