Experimental signatures of simultaneous existence of $\alpha - d$ and $^3He - t$ clusters in ^{6}Li

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Clustering in light nuclei is an interesting structure phenomenon. It is obvious to think of ^{6}Li as a cluster of $\alpha - d$ because it is energetically most favored. There have been theoretical suggestions of the simultaneous existence of $\alpha - d$ and $^3He - t$ clusters as their wavefunctions are not orthogonal [1]. Here, we report our recent findings on the existence of both these cluster structures in ^{6}Li. The experiment was performed with ^{6}Li beams from the 14UD tandem accelerator at the Australian National University incident on thin ^{58}Ni and ^{64}Zn targets. Charged fragments were measured at sub-barrier energies in coincidence using the BALIN array [2]. Breakup can be characterized by E_{rel} (the relative energy between the breakup fragments) and Q (the reconstructed Q-value). Fig. 1 (Left) shows the reconstructed Q-E_{rel} spectrum for ^{6}Li bombarding ^{58}Ni. The main mode of breakup is neutron stripping from the projectile followed by breakup of ^{5}Li into $\alpha + p$ populating several excited states of ^{59}Ni. The other significant breakup channel is direct breakup of ^{6}Li into $\alpha + d$, giving the peak at 0.7 MeV in E_{rel} corresponding to the first excited state of ^{6}Li. We observed for the first time a break-up mode in which triton is transferred to the target nucleus and the excited ^{3}He breaks up into a proton and a deuteron. Only by assuming a triton is transferred can the coincident p and d be reconstructed into sharp peaks in the Q spectrum, corresponding to excited states in the (target+triton) nucleus, as shown in Fig. 1 (Right) for the reaction with ^{64}Zn.

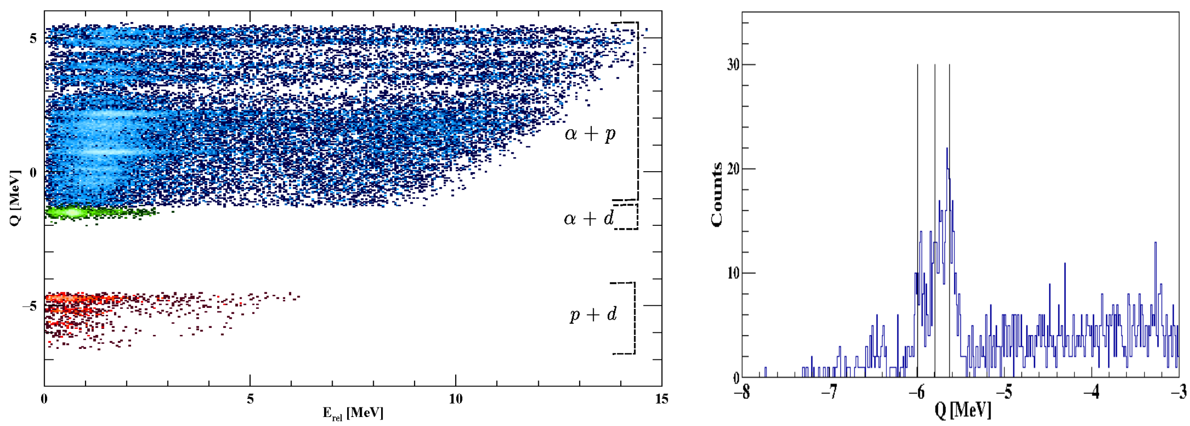

FIG. 1: Left: Two-dimensional E_{rel}-Q spectrum of breakup pairs for ^{6}Li + ^{58}Ni. The blue color is for α + p, the green color is for $\alpha + d$ and the red color is for $p + p$ breakup channel.; Right: One-dimensional Q spectrum showing peak for $^3He - t$ breakup mode for ^{6}Li + ^{64}Zn.

[1] K. Wildermuth and Y.C. Tang, *A unified theory of the nucleus* (Vieweg, Braunschweig, 1977)
[2] D. H. Luong et al., *Phys. Lett. B* **695**, 105 (2011)