neutron channels. As noted by Gray, Tickle and Bent the two proton pick-up in the Zr region using the \(^{6}\text{Li},^{8}\text{B}\) reaction is useful in studying the proton configurations of the ground state and first excited \(0^+\) states. They assume a simple direct, single-step cluster transfer and have calculated the cross sections using a finite range DWBA code. They find good agreement between calculation and experiment for two-proton transfer to the specific states. Our data represent inclusive total cross sections for two-proton transfer to all bound and neutron unstable states of \(^{91}\text{Y}\). Although the \(\alpha\)-transfer reaction is possible it is not expected to contribute greatly to the \(Y\) isotope production.

The most interesting feature of the data in Fig. 1 is the steeply rising excitation function of \(^{92}\text{Y}\) corresponding to the \((^{7}\text{Li},^{8}\text{B})\) reaction or two-proton transfer from the target in conjunction with one neutron pick-up to the target. A second possible mechanism could be the double charge exchange (DCE) reaction \((\text{pp} \rightarrow \text{nn})\) with subsequent neutron emissions. Further analysis of the data is required before we can estimate the yield of \(^{93}\text{Y}\), the DCE product.

Further work is planned at lower energies, in particular at about 60 and 75 MeV, in order to obtain a consistent set of data between the BNL and IUCF results. Later, when higher energy \(^{7}\text{Li}\) beams become available \((E_{\text{Li}} > 100 \text{ MeV})\), we hope to observe a marked increase in the cross sections of the very neutron rich \(Y\) isotopes.

1) R.S. Tickle, W.S. Gray and R.D. Bent, "Studies in the Zr Region using the \((^{6}\text{Li},^{8}\text{B})\) Two proton Pick-up Reaction." IUCF Report 121 (1979). Also see this annual report.

SEARCH FOR 3p-3h STATES IN THE \(A=12\) AND 16 SYSTEMS WITH THE \((^{6}\text{Li},t)\) AND \((^{6}\text{Li},^3\text{He})\) REACTIONS

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There has been a great deal of interest, both experimental and theoretical, in the location of three particle-three hole \((3p-3h)\) states in \(^{12}\text{C}-^{12}\text{B}\) and \(^{16}\text{O}-^{16}\text{N}\). We started to search for these states with the \((^{6}\text{Li},t)\) and \((^{6}\text{Li},^3\text{He})\) reactions on \(^{9}\text{Be}\) and \(^{13}\text{C}\) at 99 MeV bombarding energy. Due to the momentum mismatch between the entrance and exit channels and due to the geometrical coefficients in the structure amplitude, the transfer of a \((d_{5/2})^3J=13/2\) cluster is favored. Hence, final states with a configuration of \([(\text{target})_J \otimes (d_{5/2})^3J=13/2]\) are expected to be strongly excited.

Figure 1 shows spectra of the \(^{13}\text{C}(^{6}\text{Li},t)^{16}\text{O}\) and \(^{13}\text{C}(^{6}\text{Li},^3\text{He})^{16}\text{N}\) reactions. States in \(^{16}\text{O}\) at 6.13, 11.25, 14.40, 14.80, 20.80 and 24.80 MeV and states in \(^{16}\text{N}\) at 7.65, 9.81, 11.21, 11.81 and 14.00 MeV are the most strongly populated. Analog pairs of states in \(^{16}\text{N}-^{16}\text{O}\) are clearly seen.

A simple weak-coupling calculation using the method of Bansal-French-Zamick predicts the centroid of the \((3p-3h)\) states with \(T=0\) in \(^{16}\text{O}\) of the form \(^{13}\text{C}(1/2^-_{T=0},\text{g.s.}) \otimes ^{19}\text{F}(13/2^+,4.6)\) at around 15 MeV and those with \(T=1\) at around 20.5 MeV. This is approximately what is observed. The state at 20.80 MeV has a counterpart in \(^{16}\text{N}\) and therefore should have very likely \(T=1\), whereas the states at 14.40 and 14.80 MeV have
no counterparts, suggesting a T=0 assignment.


\[ \text{Figure 1. Spectra for } (^6\text{Li},^3\text{He}) \text{ and } (^6\text{Li},t) \text{ reactions on } ^{13}\text{C} \text{ at } 15^\circ. \text{ The energies in MeV of various strongly excited states are noted.} \]