Spectra (Fig.1) for Te(d,\(^6\)Li)Sn and Sn(d,\(^6\)Li)Cd have been obtained for \(E_d=33\) MeV at BNL. Complete angular distributions were measured for \(^{122}\)Te(d,\(^6\)Li)\(^{118}\)Sn. The g.s. spectroscopic strength closely follows that for (p,t) and (t,p)\(^1\) demonstrating the close correlation\(^2,\(^3\) between 2- and 4-nucleon transfer reactions. For excited states, however, the (d,\(^6\)Li) strength sometimes exceeds that of (p,t) considerably. The proton pairing-vibration state in \(^{118}\)Sn at 1758 keV, for example, is much stronger in (d,\(^6\)Li). For states with \(J>0\) the increased strength is due to coherent combinations \((L_\pi,L_\nu) [L_\pi+L_\nu=L=J]\), whereas in (p,t) only \(L_\nu=J\) is possible.

Semi-microscopic calculations have been performed for selected transitions using RCM\(^4\) and pairing wave functions. The equations of

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Fig.1. Spectra of \(^6\)Li particles from (d,\(^6\)Li) reactions at \(\theta_{\text{lab}}=16^\circ\). * Supported in part by NSF + Supported by DOE
Fig. 2. Cluster wave functions and angular distributions for $^{122}\text{Te}$ $(d,^6\text{Li})^{118}\text{Sn}(\text{g.s.})$. A: Macroscopic; B: Microscopic; c: Macroscopic with $u^2(r)\leq 0$ inside $r=6.3$ fm.

Kurath and Towner$^5$ were employed with $\alpha$-parentage amplitudes in $SU_3$ notation and wave functions generated in Woods-Saxon potential wells. About 60 contributions have to be considered for $0^+$ states, about 200-300 for $2^+$ and $3^-$ states. The interaction $V_{\alpha\alpha}$ was not treated microscopically. Fig. 2 shows the microscopic cluster wave function for $^{118}\text{Sn} + \alpha$. In the exterior region it is practically identical to the macroscopic function. Enhancement factors $\varepsilon=\sigma(\text{exp})/\sigma(\text{calc})=3.1$ and $=1.1$ for the g.s. transitions to $^{118}\text{Sn}$ and $^{114}\text{Cd}$ were found. The $0^+$ pairing-vibration state in $^{118}\text{Sn}$ has $\varepsilon=0.6$ in excellent agreement with the strength observed in $(^3\text{He},n)$.$^6$ The weak $0^+$ state at 2057 keV is well described ($\varepsilon=1$) as a 2-quasi-particle state. Transitions to $2^+$ and $3^-$ states are well described ($\varepsilon=1$) assuming only contributions from $(L_\pi,L_\nu)=(0,J)$ and $(J,0)$. One might expect, though, that for $J>3$ additional contributions become important. The dependence on $N$ for the observed $2^+,3^-,4^+,5^-$ and $7^-$ strengths is at least qualitatively understood in terms of the BCS and pairing wave functions. The pronounced increase in $7^-$ strength, for example, results from the stretched $(2d_{3/2}^2 1h_{11/2}7)$ configuration. The drastic decrease for the $0^+$ proton pairing-vibration states is not fully understood.

Using the known $\alpha$-decay of $^{148}\text{Sm}$, earlier $^{148}\text{Sm}(d,^6\text{Li})^{144}\text{Nd}$ data$^3$ make it possible to deduce the normalization constant $N$ needed in zero-range DWBA calculations. Depending on the optical parameter sets used, $N=3.8\pm 25\%$. Finite-range calculations are in good agreement with this value.