

INVESTIGATION OF ${}^6\text{Li}$ -INDUCED REACTIONS ON Pd TARGETS AT INTERMEDIATE ENERGIES

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In preparation for eventual spectroscopic study of the light In nuclei by (${}^6\text{Li}, \text{xn}$) reactions (described elsewhere in this report), we have acquired extensive excitation function data from bombardment of the light Pd nuclei with ${}^6\text{Li}$ beams of energies 55, 66, 77, 91, and 100 MeV. The portion of this data which results from the bombardment of ${}^{104,106}\text{Pd}$ is shown in Figure 1. In-beam (prompt and delayed) and off-line decay gamma-ray spectra were acquired, and the isotopes produced were identified by their known radiations. Production cross sections were determined mainly by decay data for which there is less uncertainty concerning γ -ray branching intensities. It is evident from Figure 1 that the ${}^6\text{Li}$ -induced reactions on these targets are dominated by Cd and Ag production, which can be partially understood as the result of the increasing probability for charged-particle emission by nuclei on the neutron-deficient side of the line of β -stability. In fact, the observed excitation functions are, for the most part, consistent with theoretical predictions of the Geometry-Dependent Hybrid Model (GDHM)¹⁾, which describes the time evolution of a nuclear reaction by means of compound-nuclear and pre-equilibrium emission processes. There are, however, some discrepancies between the GDHM predictions and our data. For example, the theoretical calculations predict, on the average,

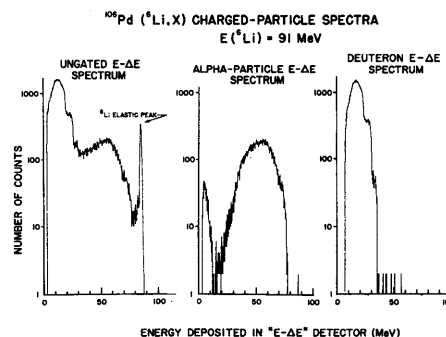


Figure 2.

approximately a factor of two more cross sections than is observed in the present measurements. It is possible to imagine several processes which would not be observed directly in-beam. For example, direct transfer reactions such as (${}^6\text{Li}, \text{d}$), (${}^6\text{Li}, \alpha$), (${}^6\text{Li}, {}^7\text{Be}$), etc. probably populate low-lying states with relatively little prompt γ -ray intensity; and these reactions could account for several hundred millibarns at the peaks of their excitation functions. Furthermore, in view of the well-known α -d cluster structure of ${}^6\text{Li}$, it is plausible that some ${}^6\text{Li}$ breakup into its cluster substructures would take place, thereby essentially removing those ${}^6\text{Li}$ nuclei from further in-beam reactions. The results of some very preliminary charged-particle spectrum measurements (Figure 2) show that copious quantities of α -particles and deuterons with beam velocity are observed, indicating the presence of breakup fragments.

The data shown in Figure 3 suggest another possible source of the α and d fragments observed in the charged-particle measurements. In this figure we

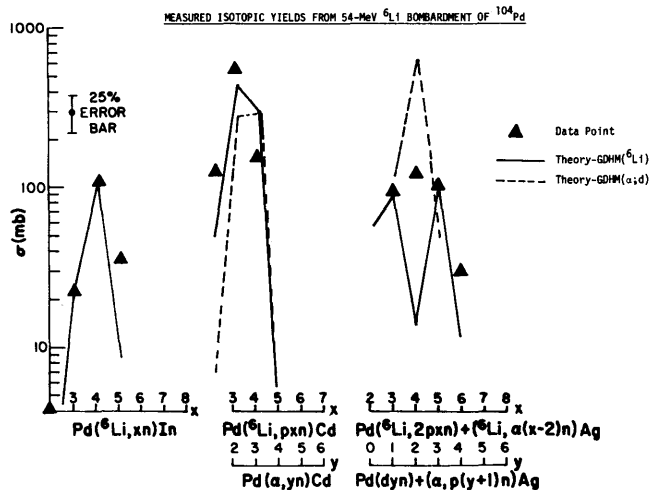


Figure 3.

plot the observed isotopic yields in comparison with GDHM calculations (solid line) for 54 MeV ${}^6\text{Li}$ on ${}^{104}\text{Pd}$. In general, the measured In and Cd yields follow the GDHM prediction for ${}^6\text{Li}$ -induced reactions very well, except for the overall factor of two mentioned above (which has been corrected for by normalization of the calculation to the In yields). The Ag yields, however, often exhibit significant discrepancies of the type seen in Figure 3, where a dramatic excess of cross section is observed in the (2p4n) exit channel. In this particular case, the (d,yn) and the (α ,pzn) reactions, where the α and the d are incident with the 54-MeV ${}^6\text{Li}$ beam velocity, are predicted by the GDHM calculations to exhibit cross sections which peak strongly in the (d,2n) and (α ,p3n) channels. This is depicted by the dotted curves in Figure 3. Such a calculation can be interpreted as a theoretical simulation of the absorption by the target nucleus of one of the ${}^6\text{Li}$ fragments, accompanied by the (d,yn) or (α ,zpyn) reactions. Thus our data, interpreted in

in this way, may suggest the occurrence of occasional breakup of the ${}^6\text{Li}$ in the nuclear field and the retention of one of the fragments by the residual nuclear system.

Further measurements (with additional collaborators) are planned whereby the charged-particle spectra will be viewed in prompt coincidence with the in-beam γ rays. These measurements will involve both light and heavy targets and should shed light on the question of the extent of the role which this breakup phenomenon plays in ${}^6\text{Li}$ -induced reactions.

- 1) M. Blann, Ann. Rev. Nucl. Sci. 25, 123 (1975).