STUDY OF THE ^{9}Li(d,p)^{10}Li REACTION

Abstract

by

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The structure of the particle unbound nucleus, ^{10}Li, was investigated in a kinematically complete experiment using the ^{9}Li(d,p)^{10}Li reaction in inverse kinematics at an incident ^{9}Li energy of 20 MeV/A. The experiment utilized the S800 Spectrograph at the National Superconducting Cyclotron Laboratory to measure the outgoing ^{9}Li from the breakup of ^{10}Li in coincidence with the recoiling protons from the (d,p) reaction which were measured using a series of silicon detectors. Based on the measured kinematics of the recoiling protons from the ^{9}Li(d,p) reaction, a lower limit to the mass of ^{10}Li was measured at $\Delta = 33.098 \pm 0.08$ MeV which is consistent with previous measurements.

A complete reconstruction of the breakup of ^{10}Li was performed based on the measured properties of the outgoing ^{9}Li nucleus, the recoiling proton, and the incident ^{9}Li beam. This reconstruction made it possible to isolate the structure of ^{10}Li associated with a ground state ^{9}Li core from structure associated with a ^{9}Li core in its first excited state. The observed ratio of ^{9}Li* core events to the total number of ^{10}Li events that were detected in the experiment was 0.098 ± 0.04 at forward center of mass angles (2.7° to 9.5°), and 0.244 ± 0.04 at more backward center of mass angles (11° to 26°). This ability to identify ^{10}Li events associated with a ^{9}Li ground state core allowed for a relatively background free measurement of the low-lying structure of ^{10}Li. The best fit to the Q-value spectra for ^{10}Li events

with a ^{9}Li ground state core yielded a state located at Q = -2.58(11) MeV which corresponds to a neutron separation energy S_n = -0.35(11) MeV. Due to the poor Q-value resolution that was observed in this experiment, however, the existence of an additional low-lying state at Q > -2.43 MeV ($S_n > -0.2$ MeV) could not be ruled out. The angular distribution of this structure was measured and compared with coupled reaction channel (CRC) calculations for an s-wave and a p-wave state. The comparison between the data and theory was inconclusive, however, in determining the nature of the observed structure in ^{10}Li.