Study of direct and sequential break-up reactions in ^{6}Li+^{112}Sn system

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Introduction

The ^{6}Li projectile while moving in the field of a target nucleus can not only dissociate into α+d but it can also first exchange a few nucleon with the target and then break up into two fragments [1]. Identification of all these processes is important to understand the break-up mechanism of ^{6}Li projectile and also to find the origin of the high yield of alpha particle production in such a reaction.

In this Paper, we present the exclusive measurement of breakup cross sections in ^{6}Li+^{112}Sn reaction exploring the above possibilities. Cross sections for both sequential as well as direct breakup are measured and compared with the theoretical calculations. The measured elastic scattering angular distributions [2] were used as a constraint to the potential parameters that were used in the calculations to explain both elastic scattering and the breakup processes simultaneously.

The experiment

The cross sections for ^{6}Li+^{112}Sn system have been measured at a bombarding energy of 30 MeV using BARC-TIFR Pelletron facility at Mumbai. Self- supporting ^{112}Sn foil of thickness$\sim$540 μg/cm^2 was used as target. Two Si-strip detector telescopes of active area 5 x 5 cm^2 (thicknesses ΔE$\sim$50 μm, E$\sim$1500 μm) with angular coverage 16.5° each were used for coincidence measurements (multiplicity=2) of outgoing fragments. Four telescopes of Si-surface barrier detectors (of thicknesses ΔE$\sim$50 μm, E$\sim$1000 μm) with 9 mm collimator diameter each, were used for measurements in coincidence for breakup fragments as well as in singles for elastic/inelastic scattering and inclusive alpha/deuteron productions. Two Si-surface barrier detectors (of thicknesses$\sim$300 μm) kept at $\pm$25° were used to monitor incident flux by measuring the Rutherford scattering.

Data analysis

In order to identify the prominent breakup channels with excitation energies, relative energy spectra were derived from the measured coincidence data for α+d, α+p and α+α particles detected at any 2 out of 32 strips as shown in Fig. 1. A huge peak at E_{rel}=0.092 MeV corresponds to breakup of ^{8}Be at its g.s. into two α particles, the peak at E_{rel}=0.71 MeV correspond to breakup into $\alpha + d$ via the 3^+ (2.18 MeV) resonant

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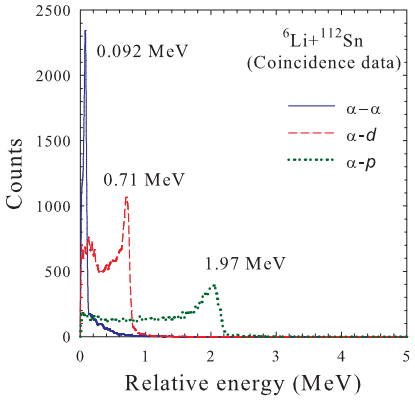

FIG. 1: Relative energy spectra.

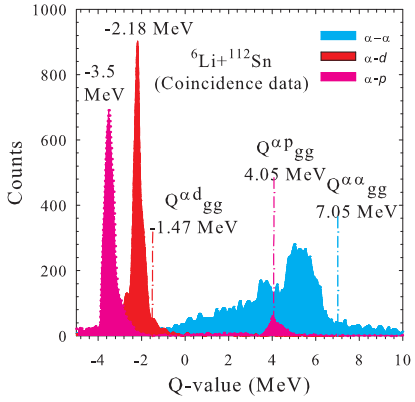

FIG. 2: Q value Spectra.

state of ^{6}Li and the peak at E_{rel}=1.97 MeV correspond to breakup into $\alpha + p$ via g.s. of ^{5}Li. From the Q-value spectra obtained from the above data to know overall excitations, shown in Fig. 2, it was found that breakup into α+d and α+p is more favorable at optimum Q value. In α+α spectrum, different peaks correspond to different excited states of ^{110}In.

The experimental differential cross-

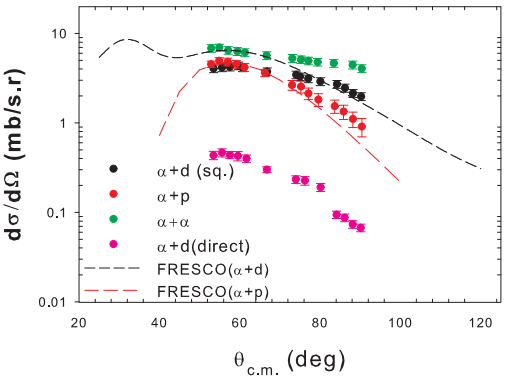

FIG. 3: Angular distribution of breakup cross-section.

sections of these channels are shown in Fig. 3. The continuum discretized coupled channels calculations using FRESCO have been performed with projectile excitation up to 8 MeV in the continuum for both direct and sequential break-up cross-sections of ^{6}Li→ α+d and compared with the experimental data. The sequential breakup, via the resonant state (3^{+} , 2.18 MeV) of ^{6}Li dominates the total α+d breakup. Coupled reaction channel calculations were performed to obtain the cross sections for transfer induced breakup cross sections for ^{6}Li→^{5}Li→ α+p which reasonably reproduce the experimental data. All the breakup channels mentioned above produce α as one of the breakup fragments which also explains why the measured inclusive alpha yield is so large .

References

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