Reaction dynamics of weakly bound stable projectile for system ^{6}Li+^{51}V

C. Joshi[1,2], H. Kumawat[2,3],* V.V. Parkar[2], V. Jha[2,3], B.J. Roy[2,3], Y.S. Sawant[2], P.C. Rout[2,3], E.T. Mirgule[2,3], R. Tripathi[3,4], R.K. Singh[1], N.L. Singh[1], and B.K. Nayak[2,3]

[1] *The M.S. University of Baroda, Vadodara-390002, INDIA*
[2] *Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*
[3] *Homi Bhabha National Institute, Anushaktinagar, Mumbai - 400085, INDIA and*
[4] *Radio Chemistry Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*

Introduction

The heavy ion nuclear reactions induced by weakly bounded projectiles is constantly possessing an importance in research studies for last two decades [1, 2]. The investigation of structure and dynamics of nuclei resting far from valley of stability is more or less approachable due to the production of radioactive ion beams(RIBs). The reaction mechanism of these certain RIBs can be better understood by studying less complex stable weakly bound nuclei like ^{6}Li,^{7}Li,^{9}Be due to higher beam intensities. For weakly bound nuclei, the coupling with and within the continuum level are precisely considerable where continuum belongs to infinite number of unbound states for a pair of interacting nuclei or unbound states of individual participants. The elastic scattering derives possible optical potential parameters which are crucial in transfer cross section calculations for final and entrance partition, specially while dealing with DWBA. In this experiment, we have measured the elastic scattering and α angular distributions for ^{6}Li+^{51}V system around Coulomb barrier.

Experimental Setup

The experiment was carried at BARC-TIFR 14-UD Pelletron Linac accelerator facility in Mumbai, India where weakly bound ^{6}Li^{3+} beam was bombarded at energies 14, 20, 23 and 26MeV. The beam current was varying in 1-28 pnA range. The self-supported ^{51}V target was having thickness of 1.17μg/cm^{2}. The setup consists of four solid state silicon surface barrier detectors in ΔE+E telescopic arrangement and two monitors. The thickness of telescope detectors were namely, T_1 with ΔE=40μm and E=1mm, T_2 with ΔE=27μm and E=1000mm, T_3 with ΔE=25μm and E=2mm and T_4 with ΔE=25μm and E=1mm. The angular range covered by telescope detectors were 14° to 170° in lab frame and monitors were placed at 10°.

Phenomenological and CDCC calculations

The FRESCO[3] computer program was used for optical model analysis of elastic scattering differential cross-section. Here, we have considered the most widely adopted functional form for phenomenological potential i.e. Wood-Saxon form factor. The initial parameter were taken from Akyuz-Winther potential, fixing geometrical parameter to 1.355 fm and

TABLE I: The best fitted optical potential parameters, reaction, breakup and inclusive-α cross-sections.

E_{lab} (MeV)	V_0 (MeV)	W_0 (MeV)	χ^2/N	σ_R (mb)	σ_α^{incl} (mb)	$\sigma_{\alpha+d}$ (mb)
26	5.099	6.566	1.5	1284.6	614.8	50.8
23	5.268	5.283	12.3	1116.9	530.9	47.4
20	8.760	8.222	1.3	1074.7	398.0	42.8
14	9.892	11.115	2.7	522.91		23.4

*Electronic address: harphool@barc.gov.in

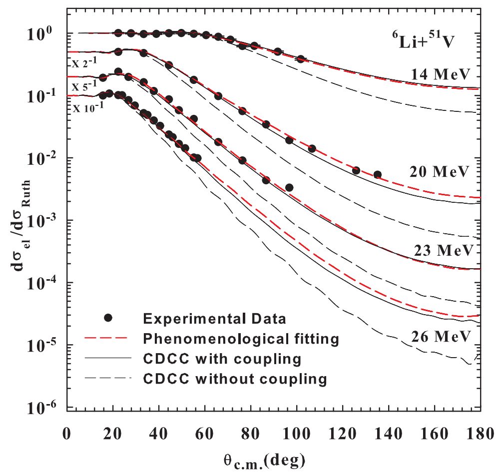

FIG. 1: Elastic Scattering cross-section for ^{6}Li+^{51}V system. Phenomenological fitting are represented by red dashed line, black solid line represents CDCC calculations with break-up coupling and black dashed line represents CDCC calculations without coupling.

diffuseness parameter a to 0.57 fm for real and imaginary parts. The best fitted depth parameters obtained at various energies with χ^2/N minimization technique are presented in Table I. The breakup (α+d) and continuum (above breakup threshold) coupling calculations are performed using São-Paulo potential. The optical model fitting and results from CDCC are presented in Fig.1.

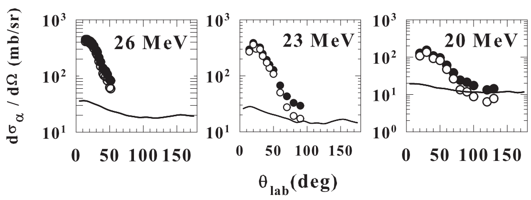

FIG. 2: Inclusive-α production cross sections at different energies. Solid circles represent total alpha cross section, solid lines depict statistical model calculations and open circles are direct (total-compound) contribution.

Inclusive-α cross-section

The inclusive (breakup+transfer induced) and fusion evaporation α spectra were measured. Fusion evaporation contribution was calculated using PACE and energy integrated angular cross section were deduced (Fig. 2). Integral cross-section were obtained [4] and are presented in Table I. The reaction (Fig.3) and inclusive-α cross-sections follow an universal mass scaling.

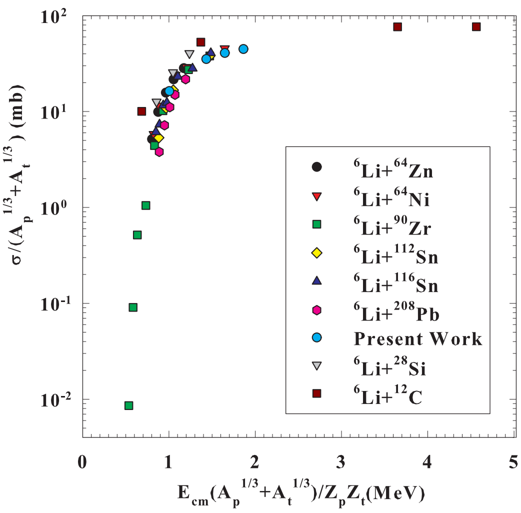

FIG. 3: Reduced reaction cross-section scaled with mass.

Acknowledgments

We are thankful to pelletron crew for providing the beam. One of the author (C.Joshi) acknowledge financial support from DST-Inspire fellowship.

References

[1] P.R.S. Gomes *et al.* Few body Sys **57**(2016)165.
[2] L.F. Canto, H. Donangelo, J. Lubian, M.S. Hussein, Phys. Rep. **596**(2015)1.
[3] I.J. Thompson, version 3.2.
[4] H. Kumawat *et al.*, Phys. Rev. **C** **81**(2010)054601.