Study of breakup effect of weakly bound ^{6}Li around Coulomb barrier energies for ^{6}Li+^{100}Mo

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Introduction

The subject of the reaction dynamics of weakly bounded heavy ions, in both stable and radioactive categories, has attracted much attention for several decades. Special attention to loosely bound nuclei is of keen interest due to the rich technical availability of radioactive ion beam. The study of elastic and inelastic scattering, transfer reactions, the breakup of projectile and fusion around the Coulomb barrier with RIB and WBP provide helpful insight into the degrees of freedom of nuclei involved. The study of the optical potential behavior that narrate the elastic scattering under the impact of any of these absorption channels is a great tool for better understanding nuclear reaction dynamics. The energy dependence of phenomenological optical potential for tightly bound systems has Threshold Anomaly (TA) behavior around the barrier. However, in the collision of WBP, TA is not observed. In such cases, the breakup cross section has quite a significant appearance even below Coulomb barrier denying the imaginary potential to decrease. This increment may be consistent as bombarding energy decreases. This increased imaginary part of potential trailed by decrease of its real part. This behavior is accounted in dispersion relation bridging real and imaginary parts of potential, which is an aftermath of causality. This anomalous dependence is Breakup Threshold Anomaly (BTA).

Experimental details

The present experiment was carried out using the General Purpose Scattering Chamber (GPSC) facility at Inter University Accelerator Centre (IUAC), New Delhi. A fine tuned ^{6}Li+ ion beam was delivered by the 15 UD Pelletron accelerator at energies 28, 25, 23, 21.5, 19, 17.5 MeV. The beam current was in 5-28 nA range. The target ^{100}Mo (99.05% enriched) was of thickness 305 μg/cm^2 with carbon backing of ~22μg/cm^2. The targets were prepared at IUAC target lab [1]. The detection was carried out using a set of seven solid state silicon surface barrier detectors in ΔE+E telescopic version. Two 300 μm thick surface barrier monitor detectors were mounted at 10° for beam monitoring and absolute normalization. The thickness of detectors were namely, T1 with ΔE=40 μm and E=2 mm, T2 with ΔE=40 μm and E=1 mm, T3, T4 and T5 with ΔE=25 μm and E= 1 mm. The telescopes were mounted inside a 1.5 m diameter scattering chamber consisting of a rotatable arm. Detectors T6 and T7 with ΔE= 25 μm and E= 300 μm were fixed at 156° and 168°. Thus, the angular range from 15° to 168° was covered in total. Every detector is collimated by a rectangular slit covering solid angles ranging from 0.9 msr to 6 msr from forward to backward angles. This ensured that all detectors had almost the same counting rate.

Phenomenological Calculations

We used the FRESCO [2] code for calculation of optical model analysis of elastic scattering differential cross section**.** The functional form of phenomenological potential was Woods- Saxon form factor. The very initial guess parameters for

Table I: Best fitted optical potential parameters and total reaction cross section

E (MeV)	**V** (MeV)	**Rv** (fm)	**av** (fm)	**W** (MeV)	**rv** (fm)	**av** (fm)	χ^2	**CS** (mb)
27.95	32.7	1.24	0.51	32.4	1.11	0.84	6.2	1375
24.94	33.9	1.24	0.52	25.0	1.10	0.86	4.1	1057
22.39	42.0	1.24	0.58	33.3	1.18	0.73	2.1	871
21.44	61.4	1.24	0.50	33.8	1.13	0.79	8.5	755
18.93	25.0	1.24	0.69	69.9	1.25	0.54	3.1	365
17.43	72.0	1.24	0.47	68.7	1.23	0.59	10.6	182

fitting were taken from Akyuz- Winther potential. All the geometrical parameters viz. depth, radius and diffusion parameter were varied altogether in the search of best fitting parameters to experimental data. The searching was within χ^2/N range. Table I shows obtained best fit parameters and associated cross sections.

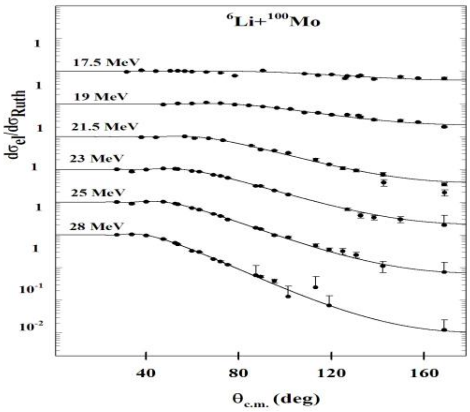

Fig I: Elastic scattering cross section for the system. Black dots represent experimental data points and solid line for optical model fitting.

Dispersion Relation

The dispersion relation establish relation between real and imaginary parts of a nuclear reaction [3]. Figure II depicts the energy dependence of potential parameters for the system ^{6}Li+^{100}Mo. We can see that as the energy approaches near barrier, imaginary part rises before closing of channels. A corresponding dip in real part can be observed manifesting BTA behavior of the system.

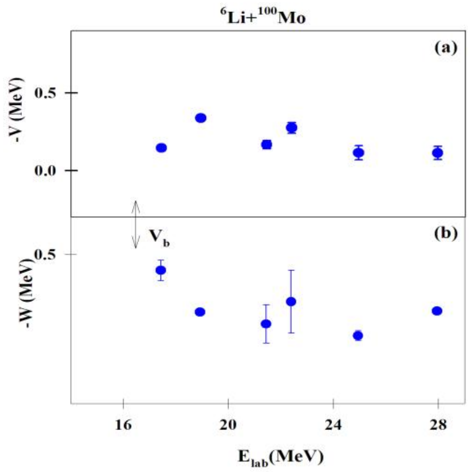

Fig II: The energy dependence of optical model potential parameters. Panel (a) and (b) represents real and imaginary part respectively.

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