Exploration of Effects of Nuclear Structure and Reaction Mechanism on the Threshold Behaviour in Nuclear Reactions with Weakly Bound Projectiles: the ^{7}Li + ^{74}Se System

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Introduction

Study of nuclear reaction mechanisms involving exotic(structurally) nuclei (like: halo, skin, …) is a frontline research in the present days with radioactive ion beam (RIB) facilities. However, many important aspects of the mechanisms (involving exotic nuclei) can be investigated/explored using stable nuclei which mimic or somewhat lie in the "doorway". For example, ^{6}Li is a stable nucleus, however it has a break-up(BU) threshold of **only 1.48** MeV in the $\alpha + d$ BU channel. While ^{7}Li has **2.47** MeV in the $\alpha + t$ channel, although it has a bound excited state at **0.478** MeV. So, nuclear reaction studies with ^{7,6}Li stable beam is of current interest. Many papers have been published by different groups around the the world. Out of many investigation aspects, one focused interest is the well known **Threshold Anomaly** (TA). In many systems like, ^{6}Li + ^{209}Bi [1], ^{6}Li + ^{138}Ba [2], ^{6}Li + ^{59}Co [3], ^{6}Li + ^{28}Si [4], … TA has **not** been observed. Or, exhibits **unusual** potential behaviour compared to normal threshold behaviour, for example, ^{6}Li + ^{208}Pb [5]. However, with ^{7}Li, TA is still present in the above mentioned systems with the exception of ^{7}Li + ^{27}Al system [6].

So, the scenario: there is **no** generalisation to **predict** whether TA will be present for ^{6}Li induced reactions while one can have some guide line for ^{7}Li as it has a bound excited state at 0.478 MeV. Moreover, transfer (like 1n, 1p, …) may also occur followed by breakup (transfer breakup) and also from the breakup fragments—BU-transfer, incomplete fusion (ICF), making the reaction mechanism more complex !

So, it is of interest to investigate TA in ^{7,6}Li + ^{74}Se (a **shape co-existing** nucleus) systems by measuring elastic scattering angular distributions around the Coulomb barrier (V_b^{lab} ~ 15.0 MeV). In the present contribution we report our measurement of the same for ^{7}Li + ^{74}Se system.

Experiment and Results

In the experiment, enriched (99.99%)^{74}Se (Z=34) of thickness 260 μg/cm^{2} with carbon backing of thickness 60 μg/cm^{2} was used as target. 8 silicon surface barrier detector telescopes (ΔE—E type) were used to detect and measure the angular distributions of elastically scattered particle at 11 ^{7}Li beam energies (E_{lab} = 12 to 18 MeV at 1 MeV step, 20, 22, 26 & 30 MeV).

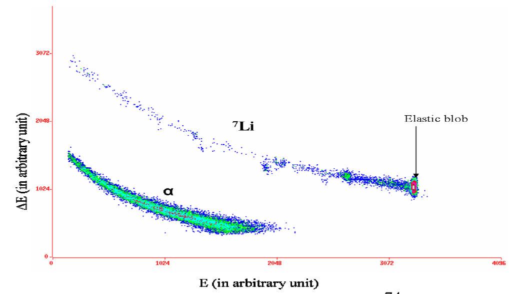


Fig. 1: Typical ΔE–E spectrum from ^{74}Se target.

To investigate any possible contribution from carbon backing in the elastic counts, carbon target of thickness 60 μg/cm^{2} was also bombarded with the same beam energy. It was found elastically scattered ^{7}Li from ^{74}Se and ^{12}C are well separated at all beam energies and angles. The measured elastic scattering angular distributions, ($\sigma_{el}/\sigma_{Ruth}$) vs $\theta_{c.m.}$, from below to above barrier energies along with optical model best fits using the search code SFRESCO have been shown in Fig. 2 and 3.

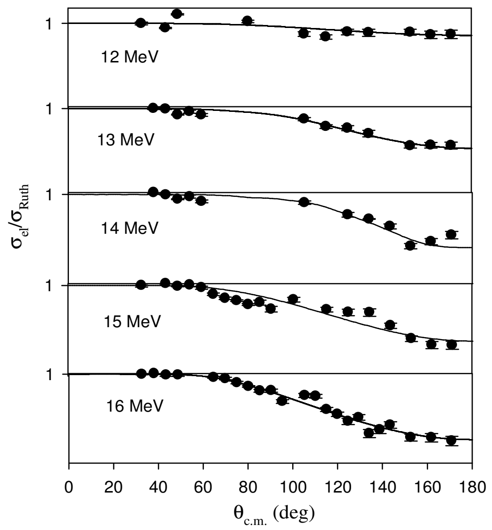
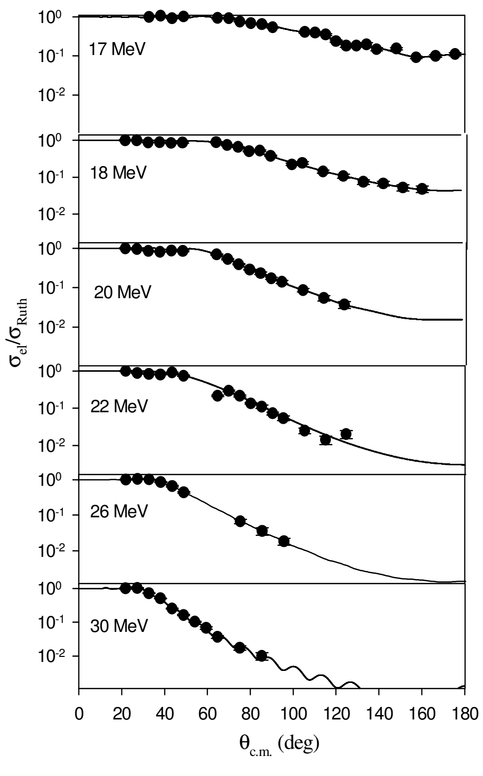
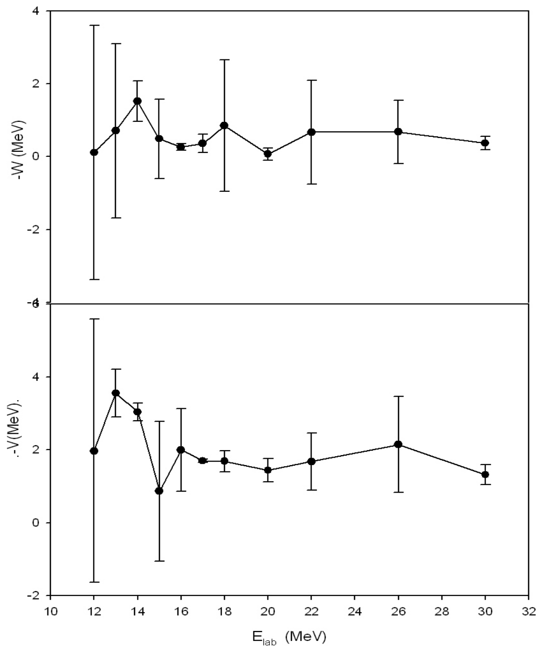


Fig. 2(above) & **3** (below)**:** Elastic scattering angular distributions at different beam energies. Solid lines are the best fits from SFRESCO.



In Fig. 4, real (V) and imaginary (W) part of the optical potentials obtained with the best fit phenomenological model are shown. The detailed analysis of the data with different models, like double folding and CDCC and also sensitivity and dispersion analysis along with the analyses of our very recently measured data for $^{6}Li + ^{74}Se$ system are in progress.

Fig. 4: Real and imaginary part of the optical potentials at R = 10.52 fm obtained from best fits phenomenological potentials.



Acknowledgements

We sincerely thank all the crew of Pelletron-Linac Facilty, TIFR, Mumbai (where the experiment was carried out) for the smooth operation of the machine during the experiment.

References

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