Elastic scattering angular distribution and threshold anomaly in the ^{7}Li + ^{159}Tb reaction

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Introduction

It is a well established fact that elastic scattering of heavy ions at energies near the Coulomb barrier, the real and the imaginary parts of the optical potential show energy dependence, known as threshold anomaly (TA) [1]. A characteristic localized peak is observed in the real part and a decrease of the imaginary part of the potential as the bombarding energy decreases towards the Coulomb barrier. This situation may change in the scattering of weakly bound nuclei [2]. These nuclei have very low breakup threshold energies and so they have a large breakup (BU) probability.

Although there has been several works on the elastic scattering of weakly bound nuclei, both stable [3–6] and radioactive [7–10], a systematic behavior of the energy dependence of the OP for such systems has not been reached.

In the present work we try to contribute to this field by investigating the elastic scattering of the ^{7}Li + ^{159}Tb system through very precise and complete angular distribution at energies from below the coulomb barrier to approximately twice this value. We have also derived the total reaction cross section for this system in order to investigate the role of BU on total reaction cross section. Earlier we have studied BTA for spherical targets and the main aim of the present experiment is to compare these results with deformed target.

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Experimental detail

The experiment was performed at the BARC-TIFR pelletron facility, Mumbai, India. The beam of ^{7}Li was delivered by the 14UD Pelletron accelerator covering the energies of 24, 26, 28, 30, 35, 40 and 44 MeV for this system.The beam current ranged from 20 to 40 enA. The beam was bombarded on self supported enriched ^{159}Tb target of thickness 1 mg/cm^2 and the elastically scattered ^{7}Li ions were detected by four solid state silicon surface barrier detectors in $\triangle$E-E telescopic arrangements. The telescopes used had a thickness (T_1) with $\triangle$E=25 μm and E= 300 μm, (T_2) with $\triangle$E=15 μm and E=1.5 mm, (T_3) with $\triangle$E=15 μm and E=1 mm and (T_4) with $\triangle$E=15μm and E=1 mm. Two monitor detectors with thickness around 300 μm were used for absolute normalization and beam monitoring.

Results and discussion

The optical model fits to the elastic scattering data were performed using the ECIS code. The real and imaginary potentials of the Woods-Saxon form were used in the calculations. In order to avoid a fit procedure with so many parameters we started the fit by changing only the real and imaginary reduced radii and diffuseness as 1.2 and 0.63 fm, respectively. After the first step, the fitting procedure was repeated by varying diffuseness parameters from 0.59 to 0.67 fm, in steps of 0.02 fm. Very good fits to the data were obtained but, as usual, we found several families of optical potential parameters that describe the angular distributions equally well. Other details of the fitting procedure are given in

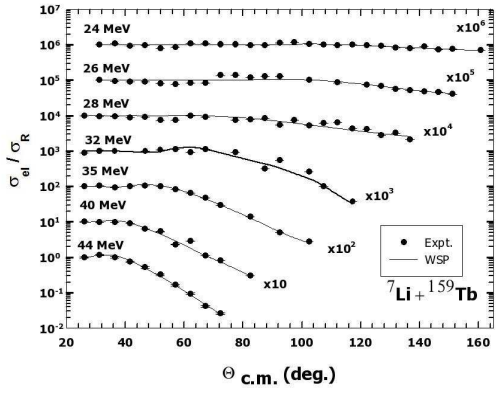

FIG. 1: Experimental elastic scattering cross sections normalized to the Rutherford cross sections as a function of $\theta_{c.m.}$ for the ^{7}Li + ^{159}Tb system and their best fits obtained from optical model calculation employing WSP potential.

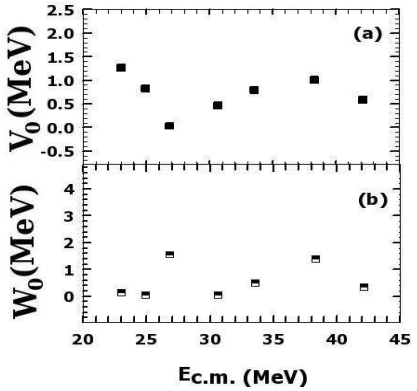

FIG. 2: Energy dependence of the real and imaginary parts of the optical potential obtained for the ^{7}Li + ^{159}Tb system at an average radius R_s=11.275 fm. The nominal Coulomb barrier is 26.6 MeV calculated using the Bass formula.

the literature [9]. Fig. 1 shows the experimental elastic scattering angular distributions and the best fit obtained, with the parameters shown in Table I. Over all very good fits to the experimental data were obtained at all energies. The corresponding energy dependence of the potential parameters are also shown in Fig. 2. No sign of threshold anomaly is observed from the energy dependence of the potential parameters. These results may be considered as preliminary. More intensive elastic scattering analysis with different form of potential is being carried out and the results will be presented in the symposium.

TABLE I: Optical Potential parameters and total reaction cross section

E_{lab}(MeV)	V_r(MeV)	V_i(MeV)	χ^2_{min}/N	σ_R(mb)
24	66.05	7	2.55	51
26	43.44	2.15	10.07	132
28	1.79	81.3	13.24	566
32	24.43	2.90	24.93	623
35	41.6	26.5	36.25	1160
40	52.7	72.49	8.28	1711
44	30.73	18.11	2.29	1579

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