Measurement of fission fragment anisotropies and excitation functions in ^{6,7}Li +^{232}Th reactions

G. Prajapati, Y. K. Gupta*, D. C. Biswas, R.P. Vind, A.L.Inkar, B. K. Nayak, L. S. Danu, P.Roy, B.N.Joshi, and B. V. John
Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA
** email:ykguptar@barc.gov.in*

Introduction

In recent years, heavy-ion reactions involving weakly bound projectiles such as ^{6,7}Li and ^{6}He are of continued interest [1, 2]. The fission fragment angular distribution is a powerful probe to understand the saddle point characteristics of the fission process [3-5]. Projectile breakup/transfer can influence the fission fragment anisotropy and the total fission cross sections [6]. In the present work, we report on results of fragment anisotropy and excitation function measurements in ^{6,7}Li +^{232}Th reactions.

Experimental Details

The beams of ^{6,7}Li in a wide energy range from 22 to 42 MeV, were obtained from 14-MV BARC – TIFR Pelletron accelerator facility at Mumbai. Thin metallic foil of ^{232}Th of thickness 1.6 mg/cm^2 was used as a target. The fission fragments were detected using two thin surface barrier silicon detectors and a cathode strip gas detector (CSGD) [7]. The CSGD was angle calibrated by measuring coincidence events between gas and silicon detectors. Two silicon detectors were kept at forward angles with respect to the beam direction to measure the Rutherford scattering events for normalization purpose. The CSGD had a total angular opening of 36^o and during analysis it was divided into five equal parts. Using both gas and silicon detectors FF angular distributions were obtained in a wide angular range. Below beam energy of 30 MeV, FF angular distributions were obtained using only CSGD because of its large solid angle. The measured FF angular distributions were transformed to centre of mass frame using appropriate Jacobian.

Data Analysis and results

The measured FF angular distributions at each beam energy were least square fitted with Legendre polynomial, using the expression;

$$W(\theta) \sim W(90^o)\,(a+b\cos^2\theta + c\cos^4\theta),$$

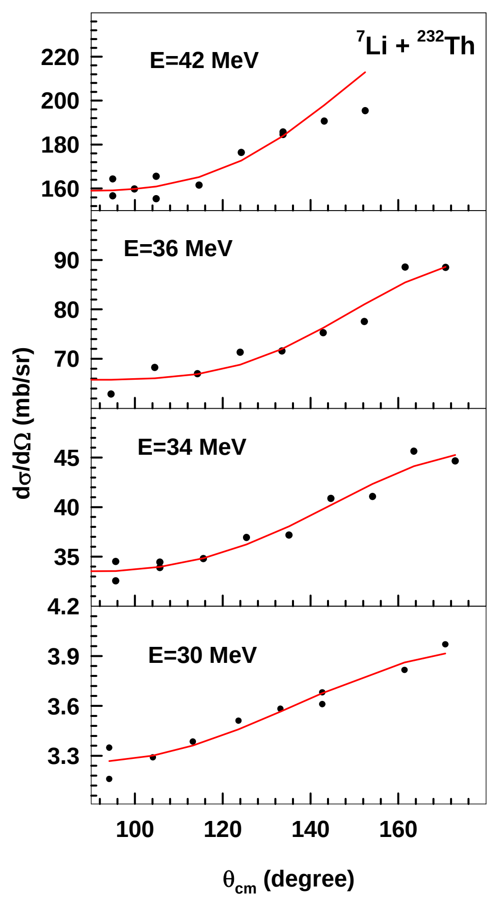

Fig. 1. FF angular distributions for ^{7}Li +^{232}Th reaction at various beam energies.

where, a, b, and c are constants and θ is a centre of mass angle of FF. Typical FF angular distributions for ^{7}Li +^{232}Th reaction at various

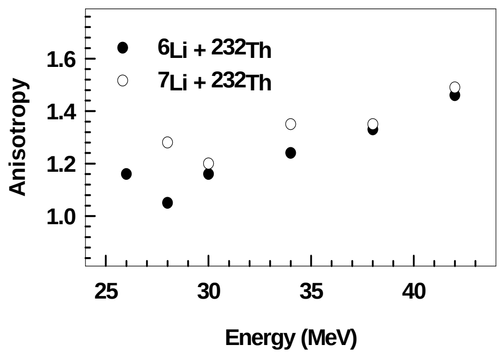

Fig.2. Angular anisotropy as a function of beam energy for ^{6,7}Li + ^{232}Th reactions.

beam energies, are shown in Fig. 1 along with least square fit. The values of FF angular anisotropy, A = W (180^{o}) / W (90^{o}), were determined at each beam energy, as shown in Fig. 2. The total fission cross sections (σ_f) were obtained by integrating the FF angular distributions. The total fission cross sections as a fuction of beam energy are shown in Fig.3 for both ^{6,7}Li + ^{232}Th reactions.

Discussion

It is observed that angular anisotropy for (^{7}Li, f) reaction remains higher than (^{6}Li, f) reaction at lower beam energies and at higher beam energies the anisotropy for both the reactions approaches to nearly the same values. Whereas total fission cross section for (^{6}Li, f) reaction is significantly higher than (^{7}Li, f) reaction at lower beam energies and at higher beam energies the cross sections for both the reactions approaches to the similar values. These discrepancies in ^{6}Li and ^{7}Li induced fission reactions can be attributed due to projectile breakup/transfer induced fission in both the reactions. This effect is more significant for ^{6}Li projectiles than ^{7}Li because of lower breakup threshold for ^{6}Li. At higher beam energies compound nucleus fission cross section is more dominant and transfer induced fission cross section is very small. Therefore, at higher beam energies the cross sections for both the reactions approaches to the similar values.

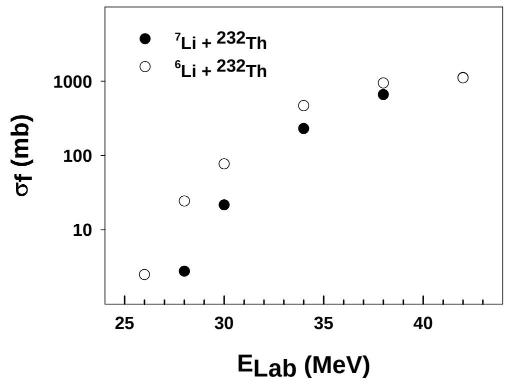

Fig. 3 Fission excitation function for in ^{6}Li and ^{7}Li induced fission reactions.

For same impact parameter, breakup/transfer induced fission events populate compound nuclei with lower excitation energy in comparison to compound nucleus fusion- fission, and therefore, angular anisotropy in breakup/transfer induced fission events is expected to be lower. The breakup/transfer induced fission cross section is higher in case of ^{6}Li +^{232}Th reaction and hence it shows lower anisotropy in comparison to ^{7}Li induced reaction at lower beam energies. Detailed data analysis and results will be presented.

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