Transfer Induced Fission Fragment Angular Distribution for ^{6}Li + ^{238}U Reaction

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Introduction

In recent years, one of the major goals of contemporary nuclear physics research is to address the physics of Super Heavy Element (SHE) production. For production of SHE one need to understand the fusion-fission dynamics.
It has been proposed to have neutron rich radioactive beams bombarding stable targets to reach the valley of stability of SHE. But heavy ion reaction studies with RIB have lead to observation of new reaction channels such as projectile breakup rather than enhancing cross section for the fusion channel. In general, projectiles with low breakup threshold affect fusion-fission reaction dynamics.

In an earlier work [1] the fission fragment anisotropy for ^{6}Li + ^{238}U system is observed to be larger in comparison to SSPM predictions for energies around the Coulomb barrier. It was suggested that the observed differences between the SSPM calculations and the experimental data are due to a combined effect of projectile breakup coupling to fusion channel and effect due to ground state spins of the projectile and target.

In order to exclusively determine anisotropy values for the various breakup/transfer channels, measurements on Fission Fragments (FF) angular distribution have been carried out on ^{6}Li + ^{238}U system for α and d transfer channels along with inclusive measurements.

Measurement Details and Analysis

Fission fragment angular distribution measurements were carried out in coincidence with projectile-like-fragments (alpha and deuteron) in the ^{6}Li + ^{238}U reaction. The experiment was carried out in the 1.0 m diameter scattering chamber. The ^{6}Li beam of energy 40 MeV obtained from BARC-TIFR Pelletron was bombarded on a ^{238}U target of thickness ~ 100 μg/cm^2, sandwiched between carbon of 15 μg/cm^2. FF were detected by using two MWPC (125 × 75 mm^2) [2] placed at 25.7 cm and 20.5 cm respectively from the target with a total angular coverage of 86.5° – 113.4° and 133.2° – 166.7° respectively. For projectile-like-fragment detection, two (ΔE, E) telescopes having silicon strip detectors (5.0×5.0 cm^2, each with 16 strips) were placed at 70° and 90° respectively, on either side of the beam direction. The thickness of the ΔE detector was 50μm and the E detector was 1.0 mm thick. Data were collected with hardware condition for coincidence between `OR' of MWPC's and `OR' of strip detectors. For inclusive fission fragment angular distribution, the hardware condition for `OR' of MWPC's was taken by scaling it down by a factor of 10.
The position information of the MWPC's was converted into angles in the analysis. In case of the transfer induced fission, the angular distributions have been obtained with respect to

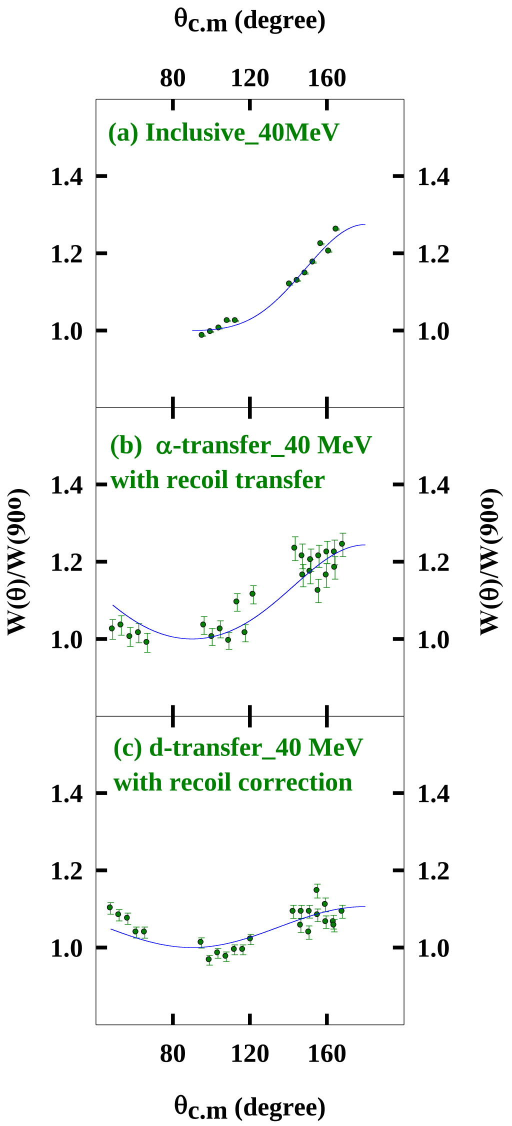

Fig.1. Fission fragment angular distributions for reaction ^{6}Li + ^{238}U at energy E_{beam}=40 MeV for (a) inclusive (total-fusion fission) (b) α- transfer and (c) d-transfer. Solid lines correspond to the fit to data to obtain FF angular anisotropy.

recoil angles of the target nucleus using two-body kinematics. Fission fragment angular distributions of inclusive as well as transfer measurement for ^{6}Li + ^{238}U system along with the theoretical fits at 40 MeV are shown in Fig. 1. These measured angular distributions in the centre-of-mass frame 'W(θ)' were fitted using Legendre polynomials (shown by solid lines) to derive the angular anisotropy values. The FF anisotropy at 40 MeV for inclusive (CF+ICF), α-transfer and d-transfer are shown in Table 1. This anisotropy value for inclusive measurement has been consistent with previous measurement Ref. [1,3].

Table 1. Anisotropy values for inclusive, α-transfer and d-transfer channels.

Energy	Inclusive	α-transfer	d-transfer
40 MeV	1.27±0.06	1.24±0.14	1.1±0.1

As shown in Table 1, it is observed that the anisotropy values for transfer induced fissions are either similar or lower than the inclusive data. This indicates that the earlier observation [1] of higher anisotropy in comparison to SSPM predictions for ^{6}Li + ^{238}U system may not be because of transfer induced fission contributions in inclusive data. Rather the present study strongly suggests the role of entrance channel ground state spin of the target and projectile contributing to the observation of higher fragment anisotropies in comparison to SSPM prediction.

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