Fission fragment angular distributions for ^{10,11}B + ^{197}Au systems

K. Mahata,* A. Shrivastava, S.K. Pandit, K. Ramachandran,
C. Palshetkar, A. Chatterjee, and S. Kailas
Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA

Introduction

The Statistical Saddle Point Model (SSPM) [1] is quite successful in explaining the measured angular distributions in heavy ion induced fusion-fission reactions. According to the SSPM, fission fragment angular distribution depends on the angular momentum (J) and its projection on the symmetry axis (K) at the saddle point. The distribution of the K states is determined by the effective moment of inertia ($\Im_{\rm eff}$) and temperature (T) at the saddle point of the fissioning nuclei. The effective moment of inertia is related to the shape of the fissioning nuclei at the saddle point.

Recently we have reported the measurement of fission fragment angular distributions for ^{12,13}C + ^{192,194,196,198}Pt systems to study the microscopic variation in the effective moment of inertia at the saddle point around N = 126 shell closure [2]. Present systems, i.e. ^{10,11}B + ^{197}Au, populate compound nuclei ^{207}Po and ^{208}Po same as those for ^{13}C + ^{194}Pt and ^{12}C + ^{196}Pt systems, respectively.

Measurement Details

The fission fragment angular distributions for ^{10,11}B + ^{197}Au systems have been measured using the BARC-TIFR 14 UD Pelletron accelerator at Mumbai. The measurements have been carried out in the laboratory energy range from 53 to 65 MeV, using 850 μg/cm^2 thick self-supporting foil of ^{197}Au. Fission fragment angular distributions were measured from 80° to 172° in laboratory using five ΔE-E telescopes. Three of the telescopes were consist of Si surface barrier detectors (thicknesses ΔE 10-22 μm, E 300 μm) and two were of integrated ΔE (10 μm)-E (300 μm) type [3]. Two Si surface barrier detectors, kept at 30° and 40° to monitor Rutherford scattering, were used for absolute normalization of fission cross sections.

Angular distributions in center of mass (W(θ)) were fitted with the standard expression for angular distribution [4]. Angular distributions for ^{10}B and ^{11}B beams at 59 MeV incident energy are shown in Fig. 1. Measured fission fragment anisotropies (A = $W(180°)/W(90°)$) are shown in Fig 2. Fission cross sections are obtained by integrating the angular distributions.

Results and discussion

For same incident energy ^{11}B will bring in larger angular momentum as compared to ^{10}B. Further, the excitation energy or temperature of the compound nucleus will be lower for ^{11}B projectile as compared to that for ^{10}B projectile due to large negative Q-value in the former case. Both these factors will lead to larger anisotropies for ^{11}B projectile as compared to those for ^{10}B projectile. The same has been observed as shown in Figs. 1, 2. The ground state spin of ^{10}B (3^+) is larger than that of ^{11}B ($3/2^-$). However, the target/ projectile spin is not expected to have significant effect in angular anisotropy in heavy ion induced fusion-fission reactions at above barrier energies and has not been considered.

Fusion cross sections (σ_{fus}) for both the systems are estimated from the measured fusion cross-section for ^{12}C+^{194}Pt system [5] by assuming same reduced cross section (σ_{fus}/r_{pt}^2) at a reduced energy ($E_{cm} \times r_{pt}/Z_p \times Z_t$), where $r_{pt} = A_p^{1/3} + A_t^{1/3}$. Since the in-

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*Electronic address: `kmahata@barc.gov.in`

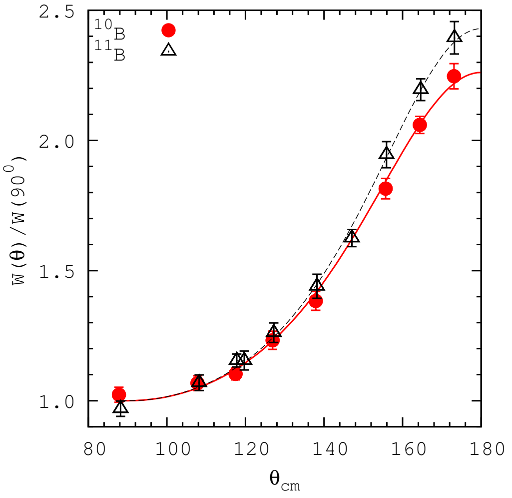

FIG. 1: Fission fragment angular distributions ^{10,11}B+^{197}Au systems at 59 MeV incident energy. The lines are fits using the standard expression discussed in the text.

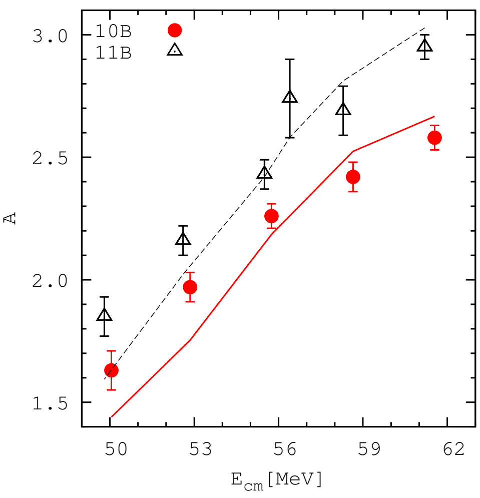

FIG. 2: Fission fragment angular anisotropy (A) values plotted as a function of energy in center of mass for ^{10,11}B+^{197}Au systems. The continuous and the dashed lines are the results of SSPM calculation for ^{10}B+^{197}Au and ^{11}B+^{197}Au, respectively.

cident energies in the present study are above the Coulomb barrier, above estimate of the fusion cross section is expected to be reasonable. Estimated fusion excitation functions are fitted using the coupled channels code CCFULL to obtain the initial angular momentum distributions of the compound nuclei.

Fission fragment angular anisotropy values are calculated according to SSPM using the (E^*, J) distributions of the fissioning nuclei for each chance. The exact expression for angular distribution has been used to calculate fission fragment anisotropy values as discussed in Ref [4]. The (E^*, J) distributions of the fissioning nuclei are obtained using the modified PACE [6] after reproducing fission probabilities $(\sigma_{fis}/\sigma_{fus})$ and prefission neutron multiplicities [7]. The values of $\Im_{eff}$ from RFRM [8] are normalized by energy independent factors to fit the anisotropy data.

The results of the $\Im_{eff}$ normalized SSPM calculations are shown in Fig. 2. The normalizing factors used are 1.15 ± 0.17 and 0.89 ± 0.08 for ^{10}B+^{197}Au and ^{11}B+^{197}Au, respectively. The normalizing factors used for ^{13}C+^{194}Pt and ^{12}C+^{196}Pt are 0.93 ± 0.05 and 1.04 ± 0.07, respectively. Normalizing factor for systems leading to same compound nucleus are found to agree within the experimental uncertainties.

References

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