Measurement of complete fusion in ^{11}B+^{144}Sm system

M. Swain[1], P. K. Rath[1],* S. Santra[2,3], V. V. Parkar[2,3], A. pal [2,3], P. C. Rout[2,3], H. Kumawat[2,3], Prabhat Mishra[2,3], M. Meher [2,3], Prasanna M.[4], N. Deshmukh [5], Pankaj Shah[5], R. Palit[6], and R. Tripathi[2,3]

[1]*Centurion University of Technology and Management, Paralakhemundi, Odisha- 761211, India*
[2]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, India*
[3]*Homi Bhabha National Institute, Anushaktinagar, Mumbai - 400094, India*
[4]*Department of Physics, Rani Channamma University, Belagavi - 591156, India*
[5]*School of Sciences, P P Savani University, Dhamdod, Kosamba, Surat – 394 125, India and*
[6]*Department of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai - 400005, India*

Introduction

Complete fusion (CF) suppression at above barrier energies has been studied with weakly bound ^{6,7}Li and ^{9}Be projectiles on several targets and a systematics has been developed [1]. Earlier, we have reported CF suppressions at above barrier energies for ^{6,7}Li+^{144,154}Sm systems [2]. There is also a study on CF suppression with ^{9}Be+^{144}Sm system [3]. In continuation with this, the measurements with ^{10,11}B+^{144}Sm system would be vital to understand the projectile dependence on same target. There are only a limited number of data available involving ^{11}B projectile, *viz.*; ^{11}B+^{159}Tb [4], ^{197}Au [5] and ^{209}Bi [6]. CF suppression of about 10% has been observed for all these reactions involving ^{11}B as projectile.

In the present work, we have measured the CF cross sections for ^{11}B+^{144}Sm system at energies around the Coulomb barrier and determined the suppression factor in CF. The compound nucleus ^{155}Ho is expected to decay mainly through neutron emission. The residues from 2n and 3n evaporation are predicted to be dominant. Small contribution from α, 1n and 1p1n evaporations will also be present. The predicted relative contributions of different residue cross sections from PACE have been used to estimate the unmeasured ER contribution to obtain complete fusion cross section. All the residues (after evaporations) have sufficient half-lives to be counted in offline γ counting method using HPGe detector.

Experimental Details

The experiment was performed at the 14UD BARC-TIFR Pelletron facility, Mumbai using ^{11}B beam incident on ^{144}Sm (94% enriched) targets having thicknesses $\sim$ 500 μg/cm^2. An Al backing has been used in the target such that the reaction products were stopped in the target. The range of energies which has been covered during the experiment was 37-64 MeV with maximum beam intensity $\sim$ 55nA. The beam flux was calculated by the total charge collected in the Faraday cup placed behind the target using a precision current integrator device. For the irradiation, a fresh target was used for each energy point. The details of the experimental method including the detection procedure of the ER is same as explained in [2]. The reaction products were identified by their characteristic γ-rays by offline counting using a high-purity Ge detector coupled to a multi-channel analyzer

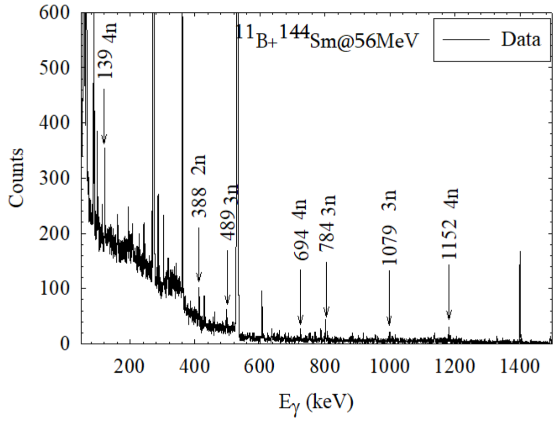

FIG. 1: A typical γ-ray spectrum showing γ lines of different ERs populated via CF in the ^{11}B+^{144}Sm reaction at projectile energy E_{lab}=56MeV..

When the projectile ^{11}B strikes the target 144Sm it forms the compound nucleus 155Ho in an excited

*Electronic address: prasanta.rath@cutm.ac.in

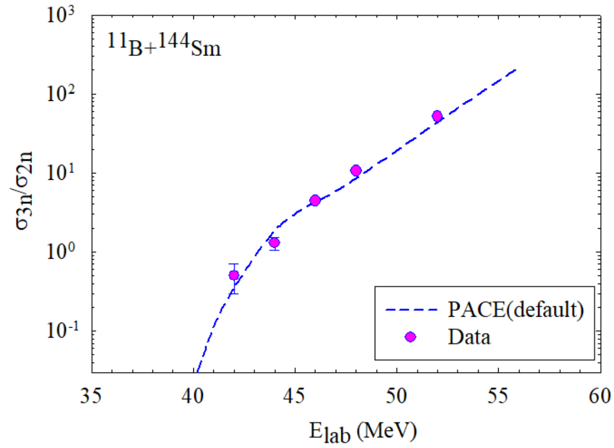

FIG. 2: Cross section ratio for σ_{3n} to σ_{2n} using the code PACE with default potential.

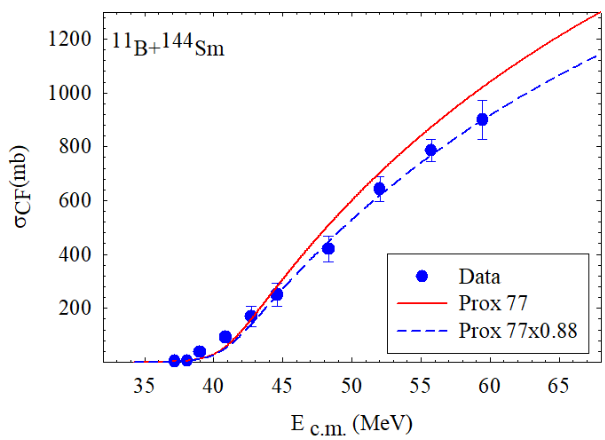

FIG. 3: Experimental CF cross sections for 11B+144Sm (circles) compared with theoretical predictions using Proximity potential (red solid line). Blue dashed line represents theoretical calculations reduced by a factor of 0.88 that reproduce the measured data.

state. The dominant decay channels for the compound nucleus after the fusion of ^{11}B were observed to be 2n and 3n evaporation leading to the ER nuclei ^{153}Ho and ^{152}Ho. Fig. 1 shows a typical raw spectrum for beam energy E_{lab}=56 MeV, where different gamma lines have been identified for different ERs populated via CF in the ^{11}B+^{144}Sm system. Cross sections for corresponding ERs were obtained following the method described in Ref [2]. To obtain the relative contribution of the missing residue channels, statistical model (SM) calculations were performed using the code PACE [7] with default potential parameters. The ratios of predicted cross sections of 3n to 2n ER channels (σ3n/σ2n) were compared with the ratios of the experimental ER cross sections as shown in Fig.2. The SM calculations are found to reproduce the experimental ratio. Hence, the relative contribution from the missing ER channels were estimated from the SM calculations and added to the measured dominant 2n and 3n ER channels to obtain the CF cross sections, as shown as solid circles in Fig.3.

The measured CF cross sections were compared with theoretical model calculations (red solid line) using Wong approximation and proximity potentials [8] as shown in Fig. 3. These potentials are parameterized from the existing fusion data in the literature for many systems involving mostly the tightly bound projectiles, providing the fusion barrier parameters like barrier height 'VB', barrier radius 'RB' and barrier curvature '$\hbar\omega$'. It is clear from Fig. 3 that the measured fusion cross sections are smaller compared to the calculation at higher energies. However, the theoretical CF cross sections when multiplied by a factor of 0.88 (shown by the blue dashed line) explains the experimental data very well. It indicates that the experimental CF cross sections for the ^{11}B+^{144}Sm system at above barrier energies are suppressed by $\sim$ 12% compared to the theoretical model calculations.

Acknowledgments

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