Effect of projectile structure on coupling strength: A systematic study

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Introduction

It is well established that the Barrier distribution (BD) is a powerful tool for understanding the degree of freedom involved in the nuclear reactions [1]. The shape of BD offers insights into the different couplings involved in the reaction processes[2, 3]. The extraction of barrier distribution requires a precise fusion excitation measurements, which are quite difficult to obtain due to low experimental cross-section and large uncertainities. Timmer et al[4] proposed an alternate method to extract the barrier distribution using quasi-elastic scattering at backward angles. The pivotal aspects of quasi-elastic scattering are the peak and width of the Barrier Distribution (BD), which account for the coupling involved during the interactions[5]. The influence of these coupling channels is governed by several factors including target and projectile structural properties. An attempt has been made to explore the projectile structure effect using quasi-elastic measurements for ^{16}O+^{165}Ho system.

Experimental Details

The experiment has been performed using the ^{16}O beam as a projectile from the 15UD Pelletron accelerator on ^{165}Ho target in the General Purpose Scattering Chamber (GPSC) facility at the Inter-University Accelerator Center (IUAC), New Delhi, India. The target ^{165}Ho of thickness $\approx 288\mu$g/cm^2 was prepared by rolling technique. The composition (99.9% enriched) and thickness of the targets were measured using the Rutherford back-scattering (RBS) facility. The incident energy of the ^{16}O beam was varied from ≈61 MeV to 85MeV in the steps of 3 MeV. The Hybrid Telescope Array (HYTAR) [6] was used to detect scattered beam-like particles (△E-E type detectors). The detecting setup consists of a set of 13 △E-E hybrid detectors and two monitor detectors having a cross-sectional diameter of 1mm, have been mounted at forward angles of $\theta_{lab} \pm 10^0$. The CANDLE was used for data analysis and cross-section was calculated using standrad formulation. Further, the barrier distribution has been extracted from measured quasi-elastic excitation function.

Analysis

The contribution of a coupling channel can be estimated from the width of the barrier distribution. The measurement of width for each coupling channel is quite difficult due experimental limitations. The commulative effect of each channels gives an overall barrier distribution. As such width can be used as cummulative coupling strength, which is the incoherent sum of all individual coupling channels. The Full width half maximum (FWHM) of the BD characterise the coupling stregnth, which can be use as a probe to understand the effect of structural properties of projectile and tar-

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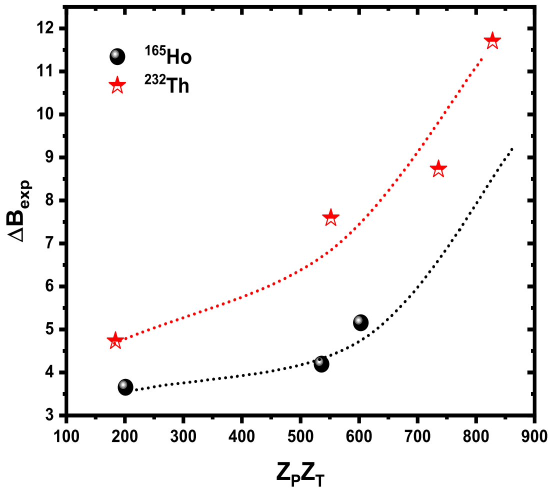

FIG. 1: The experimental width of the barrier distribution ΔB_{exp} as a function of the target projectile charge product ZpZt.

get. The standrad devitaion of BD have been calculated using relation$\sigma_B = \sqrt{(B - B_0)}$, where B_0 is the average barrier height and FWHM has been calculated using $\Delta B_{exp} = 2\sigma_B.Similarly, Barrierwidthfor^7$Li [7] and ^{19}F [8] projectiles has been determined with ^{165}Ho target and plotted as a function of ZpZt as shown in Fig. 1.

Results and Discussion

It can clearly be observed from Fig. 1, that the trend of deduced widths (shown with red stars) increases with Coulomb factor (ZpZt), which is in reference to the relation;

$$\Delta B = Z_P Z_t * StructureFactor \tag{1}$$

The non-linearity from the trend of experimental data points of BD might be due to the different structural properties of ^{7}Li, ^{16}O and ^{19}F projectiles.

Further, to strengthen the observed findings for ^{165}Ho another set of projectiles, ^{4}He, ^{12}C, ^{16}O and ^{19}F has been studied on target ^{232}Th [9] and similar trend has been observed (shown with black spheres) which validate our previous observation on ^{165}Ho target with ^{7}Li, ^{16}O, ^{19}F projectiles. Another important observation is that the magnitude of the width is large for ^{232}Th as target. It can be concluded that the Coulomb factor ZpZt has a dominant contribution in influencing the barrier width ΔB_{exp}, as expected. More detailed analysis and results will be presented during the conference.

Acknowledgments

The authors are thankful to the Director, IUAC, New Delhi, India for the experimental facilities and to the DST for providing financial support through SURE/2022/006342.

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