Study of Mass Angle Distribution in ^{30}Si+^{197}Au reaction populating ^{227}Np

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Introduction

A key area of research in nuclear physics is to investigate the unexplored Z-N plane and synthesize the super heavy element (SHE) with in the island of stability. The two competing reaction processes at near and above the Coulomb barrier are fusion-fission (FF) and quasifission (QF) as we progress to heavier systems [1, 2]. As a result of the different non-equilibrium processes, a smaller SHE production cross section is observed. Among these, quasifission is a significant hurdle to the production of SHE. Presence of QF could be inferred from anomalous fission fragment angular anisotropies, broadened fission fragment mass distributions, mass-angle correlations and strong reduction in evaporation residue (ER) cross-section [3]. Being a dynamical process, many aspects of QF process and the underlying causes are still poorly understood, necessitating a thorough case specific investigation. Here, we report the mass angle distribution measurements of ^{30}Si+^{197}Au reaction.

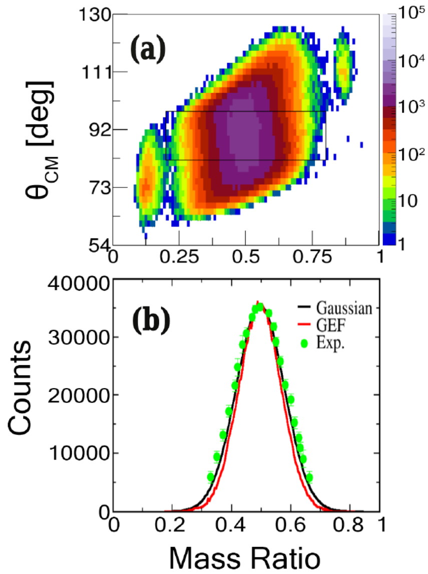

FIG. 1: (a) MAD scatter plot for the ^{30}Si+^{197}Au reaction at E_{lab} = 159.4 MeV. (b) MR distributions for the same reaction, Gaussian fit to the data and GEF MR distribution are also shown.

Experimental Details

The experiment was performed using the 15 UD Pelletron accelerator facility of the Inter University Accelerator Centre (IUAC), New Delhi. Pulsed beams of ^{30}Si from the Pelletron accelerator were further boosted in energy using the superconducting linear accelerator, with a pulse separation of 250 ns was used in the experiment to bombard self-supporting, isotopically enriched ^{197}Au target of thickness 300 μg/cm^2. Measurements were performed at the laboratory energies of the

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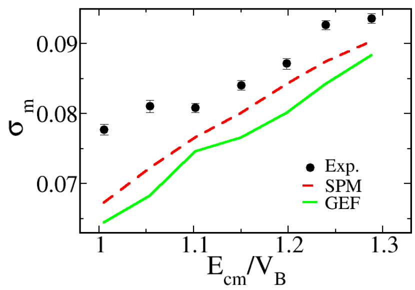

FIG. 2: Experimental σ_m values compared with theoretical values.

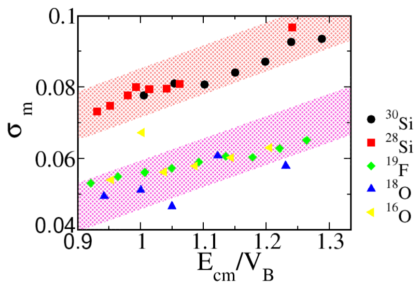

FIG. 3: σ_m values of various reactions in which ^{197}Au is the target nucleus [3, 8, 9].

range 145.3-192.4 MeV corresponding to the excitation energy range between 38 and 79 MeV. The complimentary fission/fission like fragments were detected using a pair of identical position-sensitive multiwire proportional counters (MWPCs). Both detectors have active area of 11 × 16 cm^2.

Analysis and Result

The mass angle distribution (MAD) were obtained using the position and timing signals obtained from the MWPC detectors [4]. Kinematic reconstruction method was used for this purpose [5]. FIG. 1 (a) shows the MAD plot for the reaction ^{30}Si+^{197}Au at E_{lab}= 159.4 MeV. Corresponding MR distribution is shown in FIG. 1 (b) along with MR distribution generated using GEF [6] (red curve). Gaussian fit (black curve) to the experimental distribution is also shown. Experimental σ_m values are compared with GEF [6] and scission point model (SPM) [7] calculations are shown in FIG. 2. Here, the MR width is found to be higher than the model calculation, which could be a signature of QF. However, we don't see mass-angle correlation in this reaction. Theoretical calculations predict 5-15 % probability for the QF in this reaction.

In FIG. 3, σ_m values for various reactions using ^{197}Au as the target nucleus are shown as a function of E_{cm}/V_B. ^{28,30}Si+^{197}Au reactions stand out from other three reactions, induced by ^{16,18}O and ^{19}F. No QF is observed in ^{16,18}O,^{19}F induced reactions. The increase in σ_m with E* is attributed to the temperature dependence of QF. The appearance of QF in Si induced reaction clearly demonstrate the role of $Z_P Z_T$, in determining the reaction outcome in heavy ion collisions.

Acknowledgments

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