Fission Fragment Mass Distribution Measurements for ^{24}Mg + ^{186}W reaction

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Introduction

In recent years considerable effort has been made in the production of superheavy elements using heavy ion reactions. The major hurdle in the formation of a superheavy compound nucleus or evaporation residue is the presence of a non equilibrium process called quasifission [1, 2](QF). More recent observation of the unexpected presence of QF even in asymmetric reactions froming systems as light as Po, Ra and Th[3, 4], evoked considerable interst in this field. It is important to understand the dependence of QF on the entrance channel parameter of the fusing system, in a quantitative way. In this context, we have performed mass angle correlation studies of the binary fragments produced in ^{24}Mg + ^{186}W reaction forming the composite system ^{210}Rn.

Experiment and Analysis

The experiment was performed in the General Purpose Scattering Chamber (GPSC) at Inter University Accelerator Centre, New Delhi. DC beam of ^{24}Mg from Pelletron accelerator, in the energy range 111 MeV to 125 MeV, was used to bombard on ^{186}W target of thickness 110 μg/cm^2 on 15 μg/cm^2 carbon backing. The fission fragments (FF) were detected in two large area, position sensitive multi wire proportional counters (MWPCs) of active area 20 cm X 10 cm, mounted on each arm of the chamber. The forward detector was centered at polar angle θ= 38^o (azimuthal angle ϕ= 90^o) and the backward detector was centerd at θ = 113^o(ϕ=270^o). The nearest distance to the front detector from the target was 55.5 cm and that to the back detector was 40 cm. The gas detectors were operated at a gas pressure of 3.5 mbar of isobutane gas. Positions of fragmets entering the detectors were obtained from the delay line read out of the wire planes. The position resolution of the detectors were better than 1.5 mm. Two solid state detectors were mounted at $\pm$10^o with respect to the beam direction, to monitor the elastically scattered events which in turn, were used to keep the beam always at the centre of the target. The timing pulses from both anodes were processed through constant fraction discriminators. The 'OR'ed signal of two MWPCs and two monitor detectors formed the master strobe of the data acquisition system. Individual TDCs were used for individual MWPC signals with anode as start and four position signals as individual stop. Since the beam current was very low at the required energies for ^{24}Mg, dc beam was used in the experiment and the time difference method was used for obtaining the fragment

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mass ratio distribution. The basic assumption in time difference method is the presence of only full momentum transfer reactions, which is valid in the present measurements as the target used is not fissile, the probability of incomplete momentum trnsfer processes like transfer induced fission are absent.

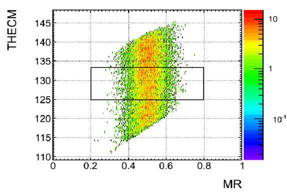

FIG. 1: The mass ratio (MR) versus centre of mass angle of fission fragments at 119 MeV beam energy.

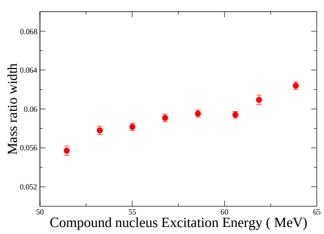

FIG. 2: The standard deviation of fission fragment mass ratio distributions (σ_m) ploted against compound nucleus excitation energy.

A TAC signal was formed by taking start signal from the anode of back detector and stop from the delayed anode signal from the front detector. The calibrated position signals (X, Y) were converted to polar angles θ and ϕ. From this and TOF information, masses of the fission fragments were determined, event by event, using the method given in ref. [5]. ^{16}O + ^{197}Au reaction, which is expected to undergo fission through pure compound nucleus formation, was used as the calibration system for obtaining the elctronic time delay involved in the measurements. In the calibration run, MWPCs were kept at 90^o in centre of mass frame, and the fragments were measured at 90 MeV beam energy. The electronic delay is calculated by imposing the condition that the mass ratio distribution is reflection symmetric about 0.5 at $\theta_{cm} = 90^o$. Fig. 1. shows the mass ratio versus centre of mass angle of the fragments from ^{24}Mg + ^{186}W at 119 MeV beam energy. From the figure it can be seen that there is no evidence of mass angle correlation for this system. The standard deviations (σ_m) of Gaussian fit to the experimental mass ratio distributions versus compound nucleus excitation energy is shown in Fig. 2. The experimentally observed mass width will be compared with the expected values from an earlier study [6], where the reaction is expected to be purely compound nucleus fission.

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