Study of fusion fission dynamics in the reaction $^{19}F+^{205}Tl$

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Introduction

In the synthesis of super heavy elements, the proper selection of the target projectile combination plays the most crucial part. While shell closed magic nuclei (e.g. ^{48}Ca as projectile in hot fusion and ^{208}Pb, ^{209}Bi in cold fusion reactions) are most preferred, the role played by this magic shell closures in the fusion fission dynamics is still not fully understood. Another factor which plays a detrimental role in the synthesis of the SHE is quasi fission, which is a competing process hindering the formation of the compound nucleus.

Experimental studies are being extensively carried out in order to disentangle the influence of magic shell closed nuclei in the fusion fission dynamics and hence understand its role in the formation of SHE. Siemenel, *et al* [1], studied the role of iso-spin in the formation of SHE. From the variation of the width of the mass distribution with entrance channel magicity, in fusion of $^{40,48}Ca$ projectiles on pre actinide targets, they indicated the possible influence of shell closed nucleus on fusion process. However, it is to be mentioned that the variation of mass width may either be due to the effect of entrance channel magicity or possible admixture of quasi-fission events. This is particularly so, as heavier projectiles like Ca were used in the experiment [1]. It is well known by now that the competing process of quasi fission scales with increasing value of Z_PZ_T.

In order to study clearly the role of the entrance channel magicity on the fusion process, without the admixture of quasi fission, reaction with charge product $Z_PZ_T < 800$ are best suited. We have initiated an experimental program to populate similar compound nuclei with different entrance channel magicity. In this work, we report the results of the fragment mass distribution in the fission of nuclei 224Th populated through the reaction channel $^{19}F + ^{205}Tl$ over a wide range of excitation energies. No influence of quasi fission is expected as $Z_PZ_T < 800$ for this reaction, and neither the target nor the projectile is magic shell closed.

Experiment

^{19}F beam of energy 80-120 MeV was extracted from the pelletron accelerator at IUAC, New Delhi and bombarded on a target of isotopic enriched ^{205}Tl of thickness 300 μgm/cm^2. Indigenously developed MWPC detectors, of active area 20 X 6 cm^2 were used for the detection of fission fragments. The detectors were placed at angles of 57^0 and 99^0, with angular coverage of 35^0 and 44^0 respectively. The detector angles were so chosen corresponding to Viola's systematics [2] of folding angle corresponding to symmetric fission following complete transfer of momentum from the projectile to the target. The detectors were operated with isobutane gas at a pressure of 3.0 torr, such that the detector is transparent to elastically scattered projectile like particles. The time of arrival of the fission fragments, the position of impact of the fission fragment and the energy loss of the fission fragment was recorded in a VME based DAQ using LAMPS.

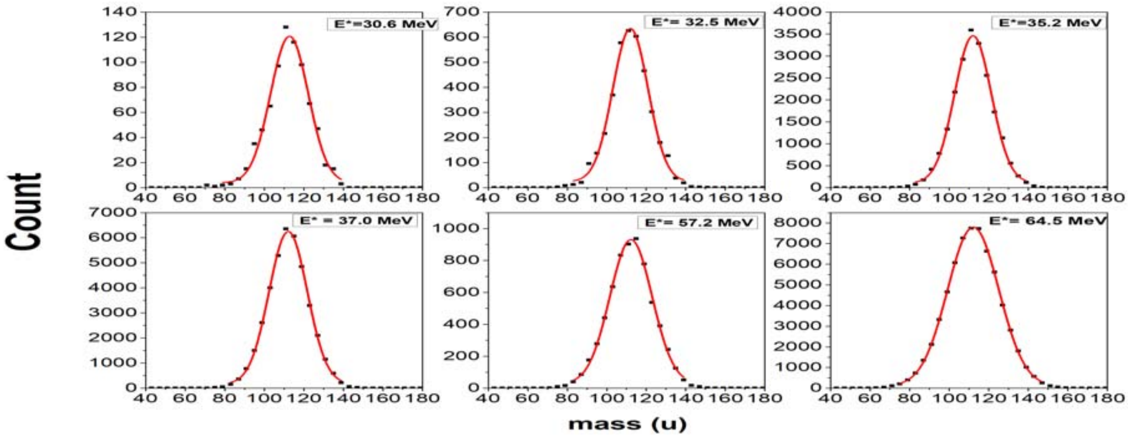

Fig 1: Fission fragment mass distribution of ^{224}Th at various excitation energies.

Results and discussions

The time of flight difference method [3] was used to calculate the fission fragment mass distribution for the reaction using the time of arrival of each fission fragment in the detector, the azimuthal and polar angles of impact and energy loss of the fragment in the gas volume of the detector. A gate of 4^0 was used around the theoretical folding angle peak to ensure that only events with complete momentum transfer was selected for construction of the mass distribution, and transfer events do not contaminate the data.

Fig 1 shows the mass distribution of the fission fragments at various excitation energies. The width of the mass distribution with increasing excitation energies are shown in fig 2. The fission fragment mass distributions were found to be symmetric in nature and could be fitted with a single Gaussian distribution (shown in red line in Fig 1). The width of the mass distribution was also found to increase with increasing excitation energy. Comparison of this data with systems of similar mass, populated with entrance channels of different magicity but with $Z_P Z_T < 800$, shall help to throw light into the role played by the entrance channel magicity in the fusion fission dynamics.

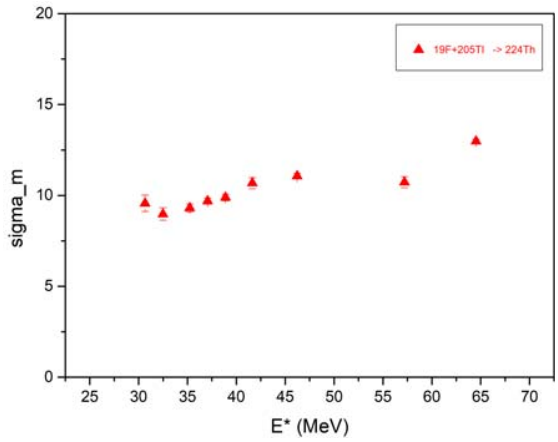

Fig 2: Width of fission fragment mass distribution of ^{224}Th with increasing excitation energy.

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