Mass distribution in ^{238}U(^{32}S,f) reaction

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Introduction

Nuclear fission is a complex process involving large scale collective rearrangement of nuclear matter. Detailed fission fragment mass distribution studies are important to understand the interplay of the structure and dynamics in the fission process. Conventional methods to study fission fragment mass distribution (by measuring the energy and/or the time of flight of the correlated fission fragments) are limited to a mass resolution of 4-5 units. On the other hand, by employing the γ-γ coincidence technique, it is possible to estimate the yield of the individual fission fragment. In our earlier work [1], we have obtained the fission fragment mass distribution by employing the γ-γ coincidence technique for the ^{238}U(^{18}O,f) system. Fine structure dips in the mass distribution, corresponding to the shell closure of the fission fragment for Z = 50 and N = 82 shells, were observed. Similar fine structure dips were also observed in the ^{208}Pb(^{18}O,f) system [2]. We interpreted these observstions in terms of *shape inhibition*, the nuclear structure effects in the fission fragment mass distribution [1]. We have further extended these experimental investigations, to systematically explore the nuclear structure effects in fusion-fission mechanism, by mass distribution measurements as a function of $Z_P Z_T$, as well as the bombarding energy. we have carried out fission fragment mass distribution studies for ^{238}U(^{32}S,f) and ^{238}U(^{12}C,f) systems. In this paper, we report the isotopic yield distribution and the fragment mass distribution for the ^{238}U(^{32}S,f) reaction at incident energies 220 MeV and 185 MeV.

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Experimental details

The experiments were carried out at the BARC-TIFR pelletron-linac facility, Mumbai. The target thickness were 20mg/cm^2 and 10mg/cm^2 for the incident beam energy (E_{lab}) 220 MeV and 185 MeV respectively. The de-exciting γ-rays were detected in the INGA (Indian National Gamma Array) [3]. The data acquisition was carried out using fast DDAQ (digital data acquisition) system based on Pixie-16 modules of XIA LLC [3]. The time-stamped data were recorded both in singles and coincidence mode, the trigger for the latter was obtained from the condition that at least two clover coincidence events occur within a time window of 1 μs.

Data analysis and results

The time-stamped data were sorted using the program MARCOS (Multi-pARameter time-stamp-based COincidence Search). Each of the clover detectors was used in add-back mode, and the add-back data were used to generate the singles γ-ray spectra, and the coincidence γ-γ matrices and γ-γ-γ cubes. Further analysis of the coincidence data was carried out using the RADWARE analysis package [4].

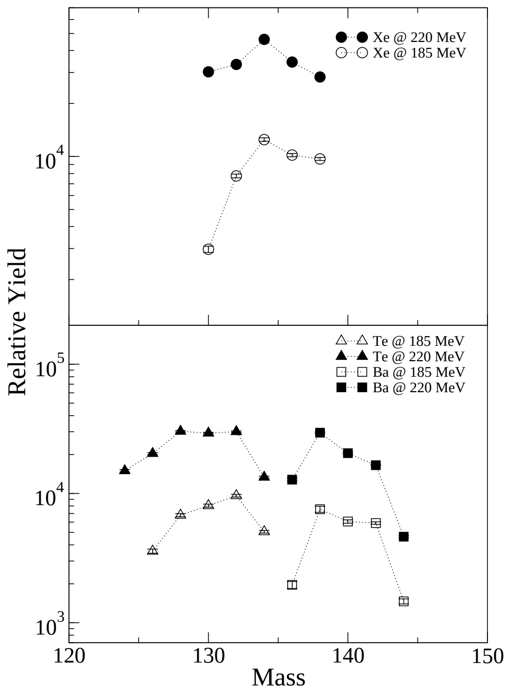

FIG. 1: Relative yield distribution of various isotopes in ^{238}U(^{32}S,f) reaction (see text for detail).

The total intensity of the $2^+ \rightarrow 0^+$ transition observed in the de-excitation of an even-even nucleus; provide the yield of the fragment isotopes to a high degree of accuracy. Therefore, the independent yield of a particular even-even fragment nucleus can be determined from the coincidence between the γ-rays of $2^+ \rightarrow 0^+$ and $4^+ \rightarrow 2^+$ transitions. The isotopic yield distributions has been obtained from the analysis of the γ-γ coincidence matrix, following the prcedure discribed ref [1]. The Isotopic yield distribution for Xe, Te and Ba for ^{238}U(^{32}S,f) reaction at incident energies 220 MeV and 185 MeV is shown in Fig. 1. The open symbol represent the isotopic yield obtained at 185 MeV and the yields at 220 MeV is shown by solid symbols. Detailed data analysis is in progress, the yield distribution of various isotopes is being carried out. The complete relative yield distribution and fragment mass distribution will be presented in the symposium.

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