Mass distribution in ^{238}U(^{12}C,f) reaction

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Introduction

Nuclear fission is a complex process as it involves large scale collective motion and rearrangement of nuclear matter into two fragments. The distribution of fragment masses is one of the most striking feature of the process and it depends on the excitation energy of the fissioning nucleus.

In case of spontaneous and thermal neutron induced fission, the mass distribution is assymetric. Also for various sysems it has been observed that the heavy fragment mass

The models does not explain for the fragment mass distribution, specially the reordering of the nucleons from an excited mono-nucleus into two (or eventually more) fragments is still a challenge for nuclear theory.

New experimental studies has enabled full identification of all fission products in A and Z for various fissioning systems [1, 2]. The systematics of available data gives a more comprehensive view on the influence of shell effects and pairing correlations on the fission- fragment mass and nuclear-charge distributions.

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 continuation to this programme 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 the present paper, we report the fragment yield distribution for the ^{238}U(^{12}C,f) reaction at incident energies 95 MeV.

Experimental details

The experiment was carried out at the BARC-TIFR pelletron-linac facility, Mumbai.

The ^{12}C beam, of energy E_{lab}= 95 MeV, was bombarded on ^{238}U target of thickness 50mg/cm^2. The de-exciting γ-rays were detected using the INGA (Indian National Gamma Array) [3] set up comprised of 21 Compton suppressed Clover detectors. The data were recorded using Fast DDAQ (Digital Data Acquisition) system based on Pixie-16 modules of XIA LLC [3] was used for data collection. The data were recorded in singles and coincidence mode. For the coincidence mode, the trigger was obtained from the the condition that at least two γ-rays are detected within a time window of 1 μs.

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Data analysis and results

Each of the clover detectors was used in add-back mode, and their addback spectra were generated in the offline analysis. The addback data was then sorted using the program MARCOS (Multi-pARameter time-stamp-based COincidence Search) to obtain the double (γ-γ matrix) and triple (γ-γ-γ cube) coincidences. The coincidence window for the data collection was 1 μs. Using MARCOS, the data were sorted into γ-γ matrices and γ-γ-γ cubes for the coincedence windows of 200 ns, 400 ns and 800ns. These γ-γ matrices and γ-γ-γ cubes were then analysed for the prompt and delayed coincedences, using the RADWARE package [4].

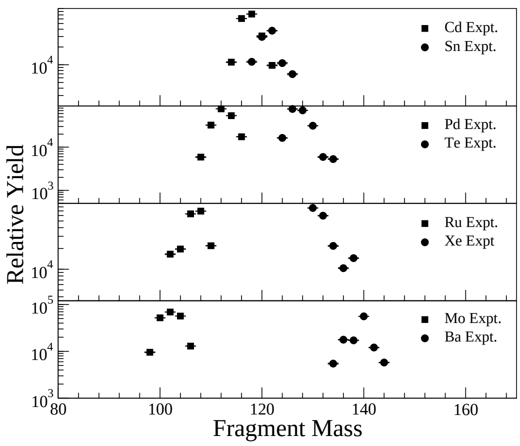

FIG. 1: Relative yield distribution of various isotopes in ^{238}U(^{12}C,f) reaction.

The fragment yield has been obtained from the γ-γ coincidences, as described in ref [1]. The total intensity of the $2^+ \rightarrow 0^+$ transition observed in the de-excitation of even-even fragments provide its yield to a high degree of accuracy. Therefore, the yield of even-even fragments was estimated from the intesity $2^+ \rightarrow 0^+$ transition in the coincidence with the $4^+ \rightarrow 2^+$ transition. The fragment yield distribution for Cd-Sn, Pd-Te, Ru-Xe and Mo-Ba pairs is shown in Fig. 1. The isotopic distribution follows a bell shaped curve, and it is maximum for 8-10 neutron evaporation. Data analysis is in progress. The yield distribution of other isotopes is being carried out. The yield and mass distribution alongwith theoretical calculation will be presented in the symposium.

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