Isotopic and Isobaric Mass Distributions of Fission-like events in ^{19}F + ^{159}Tb system at Low Energies

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Introduction

In recent decades, fission is found to be a competing mode in the nuclear reactions with fusion process [1]. At low excitation energies, the dynamics of heavy-ion induced fission process has attracted attention both theoretically as well as experimentally, as it is expected to occurr at relatively high energies. Recently, fission of the residues populated via complete and incomplete fusion of projectile with heavy target has been observed at low excitation energies, where fusion is expected to be a dominant reaction process [2, 3].

Depending upon the available excitation energy and other entrance channel parameters, the composite system formed due to fusion of two heavy nuclei, may decay either by emitting light nuclear particles or by populating the fission fragments of mass nearly equal to half of the mass of composite system i.e. fissioning of the composite system. The fission process may be characterized by different experimental probes like angular distribution and mass distribution etc. Nishio *et al.* [4] and Hinde *et al.* [5] have found fission along with fusion at different energies near the Coulomb barrier to well above it.

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Experimental details

In the present study, 26 fission-like fragments in the mass range of $74 \leqslant A \leqslant 93$ are identified in ^{19}F + ^{159}Tb system at three different excitation energies i.e. $\approx$ 5.5, 5.6, and 5.8 MeV/A, respectively. The recoil-catcher technique followed by off-line γ-ray spectroscopy has been employed to detect the fission-like events. The experiments have been carried out at the Inter University Accelerator Center (IUAC), New Delhi, India, using the beam of ^{19}F produced by 15UD pelletron accelerator. The targets of natural ^{159}Tb and Al catcher foil have been prepared using rolling technique. The thicknesses of target and catcher foils were measured by α-transmission method in which α-particles of 5.487 MeV obtained from a standard ^{241}Am source were allowed to fall on the target foil and by determining energy loss. The irradiations have been carried out in the General Purpose Scattering Chamber (GPSC). An in-vacuum transfer facility is used to minimize time lapse between the stop of irradiation and start of counting of samples. The reaction residues were detected using High Purity Germanium (HPGe) detector having resolution $\approx$ 2 keV for 1333 keV γ-ray of ^{60}Co. Intensities of identified γ-rays of the radioactive residues are used to determine the cross-sections, employing standard formulations [6].

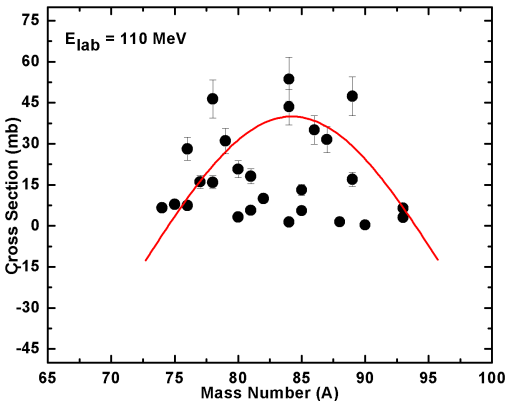

FIG. 1: Measured mass distribution of fission-like fragments in ^{19}F + ^{159}Tb system at E$_{lab}$ ≈ 110 MeV.

Mass distribution of fission-like fragments

As a representative case the measured mass distribution of fission-like fragments populated in ^{19}F + ^{159}Tb system at E$_{lab}$ ≈ 110 MeV is shown in the Fig.1. As can be seen from this figure that this mass distribution of fission-like fragments is broad, symmetric and Gaussian, suggesting the population of these fragments via fission of residues populated from complete and/or incomplete fusion process.

Isotopic and isobaric yield distributions

At low excitation energies due to large Coulomb barrier, emission of charged particle(s) is obstructed and emission of neutrons competes directly with the process of fission which gives rise to isotopic and isobaric distributions of fission-like fragments. Isotopic and isobaric yield distributions of identified fission-like fragments populated via complete and/or incomplete fusion are found to be Gaussian. It is pointed out that the dispersion parameters (σ_z) are found to be in good agreement with related literature. As a representative case, isotopic yield distributions of Sr and Y isotopes are shown in the Fig.2, at E$_{lab}$ ≈ 110 MeV. Further details of the measurements and analysis will be presented.

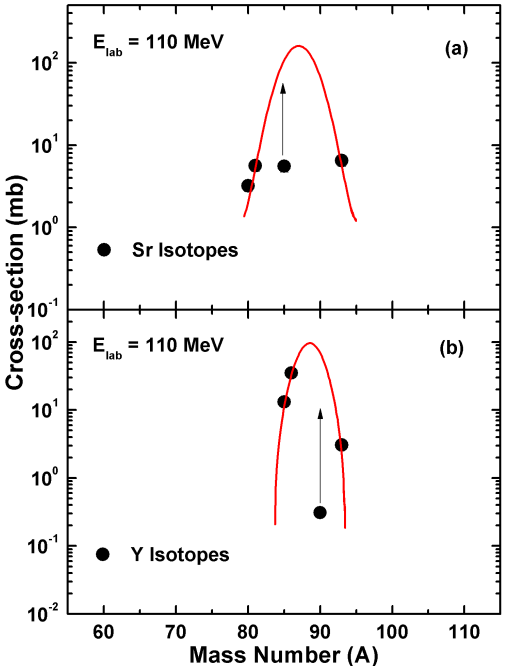

FIG. 2: Isotopic yield distributions of Sr and Y isotopes produced in ^{19}F + ^{159}Tb system at E$_{lab}$ ≈ 110 MeV.

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