Fission Fragment mass distribution of ^{203}At in reaction ^{28}Si + ^{175}Lu

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1. Introduction

The impact of entrance channel effects on fission dynamics near and above the Coulomb barrier has become an active area of research in nuclear physics both experimentally and theoretically [1-3]. Various studies have been done to explore the several types of fission processes. In a heavy-ion (HI) fusion reaction, the projectile nucleus having beam energy more than Coulomb barrier fuses with the target nucleus. The compound nucleus (CN) in the excited state is cooled by releasing its excitation energy either by producing the fission fragments in fusion-fission (FF) process or by emission of light particles (such as neutron, proton, alpha) in fusion-evaporation process. In case of FF process, the di-nuclear system can split into two separate nuclei with the emission of several protons and neutrons. Aiming to explore the dynamics of the fusion-fission process in the heavy mass region, the mass distribution for reaction ^{28}Si+^{175}Lu is measured.

2. Experimental Setup

The experiment was carried out at the Inter-University Accelerator Centre (IUAC), New Delhi. The fission fragments were produced by bombarding ^{28}Si beam at 155 MeV on thick self-supporting ^{175}Lu (3.2 mg cm^{-2}) target.

The delayed γ rays from the de-exciting nuclei were detected by the Indian National Gamma Array (INGA) consisting of 12 Compton-suppressed Clover Ge detectors [4] placed around the target. Offline γ spectroscopy was used to measure the production cross-sections of fission-like events. The fission fragments were identified by their characteristic γ rays and confirmed by the decay curve analysis. The calibration of the detector was done using γ sources standard (^{60}Co and ^{152}Eu) of known strengths.

3. Data Analysis and Discussion

The identification of reaction products was done explicitly based on the characteristic γ rays and half-lives obtained from the decay curve analysis. A typical γ rays spectrum obtained at $E_{lab} \approx 155$ MeV for ^{28}Si+^{175}Lu system is shown in Fig. 1.

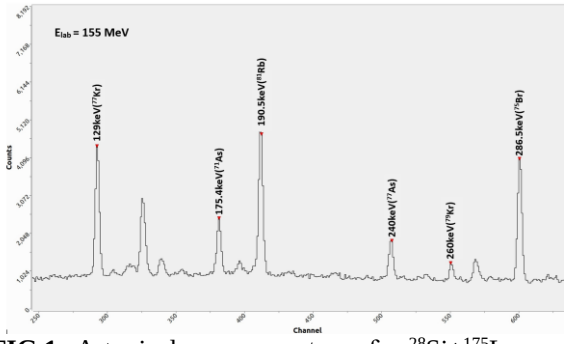

FIG.1: A typical γ rays spectrum for ^{28}Si+^{175}Lu system at E_{lab} = 155 MeV.

Decay γ lines assigned to different fission fragments were followed at

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increasing times after the stop of irradiation. In order to get decay curves for individual γ lines, the count rate was plotted as the function of lapse time for each fragment.

The decay curves of ^{74}Br, ^{75}Br and ^{77}Kr were achieved by following the 634 keV, 286.5 keV and 129 keV γ as shown in Fig. 2 . As can be seen from this figure, half-life corresponding to the above-formed fragments are found to be 25.4 min, 74.4 min and 96.7 min respectively which confirm well with the literature (characteristic half-life of ^{74}Br,^{75}Br and^{77}Kr respectively).

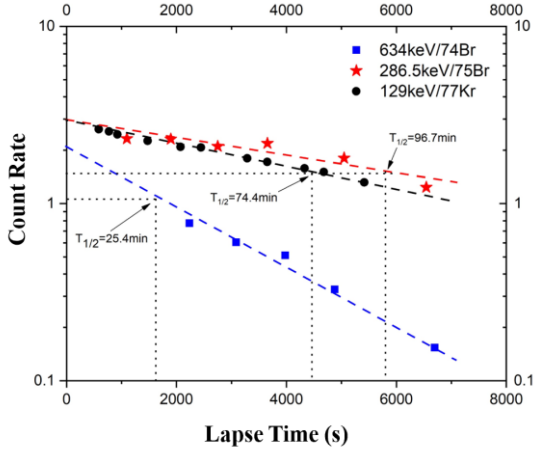

FIG.2: Decay curves of ^{74}Br,^{75}Br and^{77}Kr are shown. Dashed lines are the linear fit through data points.

The cross-section of FF residues has been calculated using standard activation equation [5],

$$\sigma_{ER} = \frac{C_{t=0}}{N_0 \theta \varphi G_\varepsilon K (1 - e^{-\lambda t_1})}$$

where $C_{t=0}$ is the count rate, N_0 is the initial number of target nuclei per unit area, θ is the branching ratio of the characteristic rays, φ is the geometry-dependent efficiency of the detector, K is the self-absorption correction factor, λ is the decay constant of the evaporation residue, and t_1 is the duration of irradiation. Decay γ lines for identified fission fragments are given in Table 1 along with other spectroscopic properties [6]. Fission fragments analysis is underway, and detailed results will be presented during the conference.

Table 1: Spectroscopic data of fission fragments identified in the present work

Serial No.	E_γ (keV)	I_γ (%)	Nuclide	Half-life ($T_{1/2}$)
1	175.4	80	^{71}As	65.3 h
2	835	80	^{72}As	26 h
3	595	59	^{74}As	17.77 d
4	634.3	14.1	^{74}Br	25.4 min
5	286.5	88	^{75}Br	96.7 min
6	560	45	^{76}As	1 d
7	559.1	74	^{76}Br	16.2 h
8	451.9	90	^{76}Kr	14.8 h
9	240	1.6	^{77}As	38.83 h
10	129	80	^{77}Kr	74.4 m
11	520.6	22.4	^{77}Br	57.04 h
12	454.97	63	^{78}Rb	17.6 min
13	688.1	23	^{79}Rb	22.9 min
14	260	13	^{79}Kr	35 h
15	190.46	64	^{81}Rb	4.57 h
16	554.38	62	^{82}Rb^{m}	6.4 h
17	617.7	19	^{200}Po	10.9 min

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