Mass distribution of fission-like fragments formed in ^{20}Ne + ^{165}Ho system at $E_{lab} \approx 8.2$ MeV/A

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Introduction

Nuclear fission is a dominant reaction mechanism in heavy ion interaction at moderate excitation energies [1, 2]. Recent experimental data has indicated the presence of nuclear fission in heavy mass targets using heavy ion projectiles at low energies. The study of the interplay of fusion-fission processes with the Coulomb factor ($Z_PZ_T \approx 700$) has been an active field of investigation from past few decades. There are two important observable in nuclear fission such as charge and mass distributions. The charge and mass are directly related to the collective dynamics of the fission process. The data on mass and charge distributions also provide a testing ground for various theoretical models. Through the experimental studies, it has been observed that depending upon the excitation energy, angular momentum, mass asymmetry of the entrance channel and other parameters [3, 4], the composite system formed as a result of HI collision either forms an equilibrated compound nucleus or undergoes fission before equilibration. Fusion-fission gives important information about the dynamics of the heavy ion induced reactions. Further, fission like fragments may also arise due to the partial linear momentum transfer (termed as incomplete fusion-fission (IFF) fragments) and/or by the full linear momentum transfer (termed as complete fusion-fission (CFF) fragments). In such heavy ion reactions, the excitation energy and angular momentum imparted in the system are relatively higher; as such the process of fission is also a dominant mode of reaction above the coulomb barrier of the heavier system. In the present work, an attempt has been made to study CFF and IFF in ^{20}Ne + ^{165}Ho system at projectile energy ≈ 8.2 MeV/A. Twelve fission like fragments (FLF) produced through CFF and/or IFF in the present system have been identified. The production cross-sections of identified fission like fragments have been measured and study the mass distribution of fission like fragments along with earlier work [5].

Experimental Details

The present experiment for the study of CFF and IFF processes in ^{20}Ne + ^{165}Ho system at projectile energy ≈ 8.2 MeV/A was performed using heavy ion experimental facility at Variable Energy Cyclotron Centre (VECC), Kolkata, India. Self-supporting natural ^{165}Ho targets of desired thickness with purity 99.9% were prepared by rolling technique. The thickness of each target foils was determined using micro-balance as well as by α-particle transmission method. A stack of target-catcher assemblies were bombarded with the ^{20}Ne-ion beam in a specially designed vacuum chamber. Stack consisting of rolled holmium foils each of ^{165}Ho backed by thick aluminum foils were bombarded with a ^{20}Ne-ion beam of energy ≈ 8.2 MeV/A. The weighted average beam current of about ≈ 60 nA behind the target assembly was measured with an electron suppressed Faraday cup, using a current integrator device. The stack have been irradiation for ≈ 8 hours. The residual γ-activities produced in various targets along with its aluminum catcher foils were recorded, after irradiation. The identification of fission like

fragments produced through CFF and IFF has been identified by characteristic γ-rays and following their half-lives.

Results and Discussions

The twelve fission like fragments ^{61}Co, ^{75}Br, ^{78}Ge, ^{80}Sr, ^{87}Sr, ^{90}Y, ^{91}Y, ^{104}Ag, ^{129}Te, ^{132}Ce, ^{149}Nd, and ^{152}Dy produced through CFF and/or IFF in ^{20}Ne+^{165}Ho system have been identified. Measured cross-sections of fission like fragments are plotted as a function of their atomic mass numbers and is shown in Fig. 1. The total production cross-sections of measured fission like fragments are found to be ≈516.62 mb at studied energy. It has been noticed that from the measured values of total fission like cross-section give only a lower limit as many fission like fragments could not be observed in the present work due to either they having short half-lives or are stable. The measured mass distribution of fission like fragments have been found to be symmetric, which is expected. It is pointed out that the fission like fragments, which recoil in the backward direction are lost and no correction for this is applied. However, if catcher foils are put at both sides of the target, then both the fragments of a particular fission event in forward and backward directions may be trapped and identified. Further, only the ground or meta-stable states of some fission like fragments have been observed. Hence, cross-sections of these fission like fragments are expected to go up and shown by upward arrows in Fig. 1. The cross-sections of evaporation residues (ERs) produced through CF and ICF reactions have been taken from our earlier work [6]. In this figure, the narrow peak towards higher mass numbers may be attributed to the evaporation residues formed by CF and/or ICF reactions, while the broad peak in the intermediate mass region may be assigned to CFF and/or IFF events. The present measurements indicate that apart from CF and ICF processes [6], fission of the excited composite system is also quite significant. The present observations indicate that contributions of fission should also be taken into account while predicting the total reaction cross-sections. The present findings are also supported with earlier measurements [7, 8].

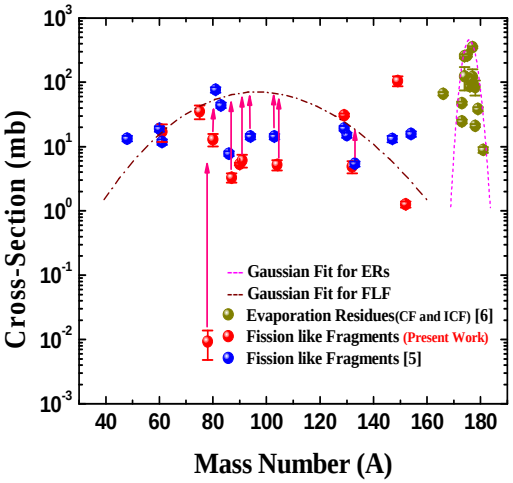

Fig.1. (Color online) Mass distribution for the fission like fragments and evaporation residues of CF and ICF produced in ^{20}Ne + ^{165}Ho system at E_{Lab} ≈ 8.2 MeV/A.

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