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Channel-by-Channel Measurement of Excitation Functions of Reaction Residues in ^{12}C+^{193}Ir System at E$_{lab}$ = 64−84 MeV

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Introduction

The heavy-ion-induced reactions at low incident energies, depending on different angular momentum and/or impact parameters within the target dimensions, lead to two main reaction processes: complete (CF) and incomplete fusion (ICF) [1, 2]. In CF, the interacting partners can be trapped in the pocket of the entrance channel potential involving all nucleonic degrees of freedom. However, fractional momentum transfer occurs in the case of ICF, leading to the formation of the incompletely fused composite system. To investigate different aspects of these reactions, an experiment has been carried out at the Inter-University Accelerator Centre (IUAC) in New Delhi, India, to measure Channel-by-Channel excitation functions (EFs) of reaction residues in ^{12}C+^{193}Ir system at E$_{lab}$ = 64−84 MeV.

Experimental details

The ^{193}Ir (99.9% enriched) target foils of thickness 17-60 μg/cm^2 were prepared using ultra-high vacuum deposition technique [3]. The target-catcher assemblies were irradiated using ^{12}C beam at energies E$_{lab}$ = 64−84 MeV in General Purpose Scattering Chamber (GPSC). Post irradiation, the target-catcher assemblies were taken out of the chamber using an in-vacuum transfer facility and counted offline using pre-calibrated high-purity germanium (HPGe) clover detectors coupled with a CAMAC-based data acquisition system. The energy and efficiency calibrations of the HPGe clovers performed using a standard ^{152}Eu γ-ray source are shown in Fig 1(a). The γ-ray spectra have been analyzed using the CANDLE, and the reaction residues were identified using their characteristic γ-rays and confirmed through the decay-curve analysis. A decay curve of ^{201}Bi indicating a half-life of 103.4 min is shown in Fig 1(b).

Results and Analysis

In the preliminary analysis of ^{12}C+^{193}Ir reaction data, five evaporation residues (ERs) have been identified to be populated via decay of ^{205}Bi*, and compared with theoretical model code PACE4 [4]. Fig 2 shows the experimentally measured EFs of the ^{201}Bi and ^{198}Tl residues populated via 4n and α3n channels, respectively. As can be seen from this figure, the cross-sections of ^{201}Bi(4n) are very well reproduced by the PACE4 predictions, indicating the population of ^{201}Bi via emission of 4 neutrons from the ^{205}Bi* excited nucleus. In contrast, the measured cross-sections of ^{198}Tl(α3n) are significantly enhanced compared to PACE4 calculations, indicating the onset of ICF channels. The residue ^{198}Tl may be populated via both CF and ICF (i.e., the breakup of ^{12}C into α+^{8}Be). Further data analysis is ongoing, and the detailed results and analysis will be presented during the symposium.

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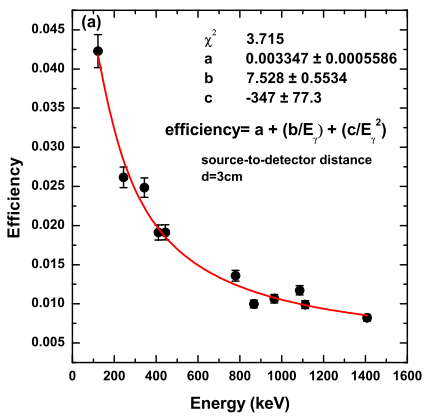

FIG. 1: (a) The efficiency curve for HPGe Clover Detector using an ^{152}Eu γ-source at 3 cm, and (b) the decay-curve of ^{201}Bi (103.4 min) residue.

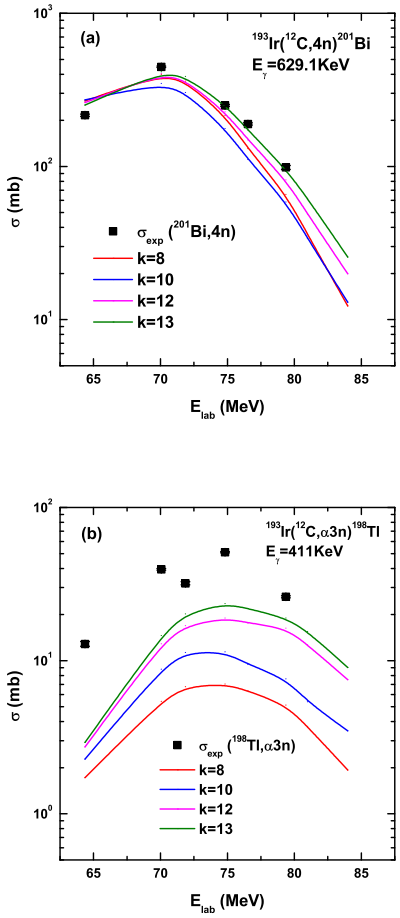

FIG. 2: The experimental EFs of (a) ^{201}Bi (4n) and (b) ^{198}Tl (α3n) residues compared with the PACE4 calculation for different values of K.

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