Spin Distribution measurements in ^{16}O+^{159}Tb system

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Introduction

Incomplete fusion (ICF) in HI-induced (A $\leq$ 20) reactions has been a topic of renewed interest after the observation of such processes even at energies near and/or just above the fusion barrier [1]. The first evidence of incomplete fusion reaction dynamics also referred to as massive transfer reactions was presented by Kauffmann and Wolfgang [2] by studying ^{12}C+^{nat}Rh system at $\approx$ 7-10 MeV/nucleon, where strongly forward peaked light nuclear particles have been observed. Britt and Quinton [3] found similar observations in the reaction ^{16}O+^{209}Bi at energies from $\approx$ 7-10 MeV/nucleon. In these measurements, significantly large yield of direct emitting α-particles of mean energy roughly corresponding to the projectile velocity at forward angels has been observed. It is suggested that the principal process involved in the production of fast-α-particles is the projectile break-up, in the nuclear field of target nucleus, in a grazing interaction through the surface of target nucleus. Since then, the question of fast projectile-like-fragment(PLF) production has been studied quite intensively. In one of our recent papers, the fast α particle in the forward cone at low projectile energies has also been reported [4]. One of the important issues related to ICF studies is the localization of ℓ-window at low energies ($\approx$ 4-7 MeV/A). It may be pertinent to mention that high spin states can also be populated through ICF reactions. In order to explore the issues related to the dynamics of ICF processes and to get information regarding the involvement of mean input angular momenta in such reactions, a particle-γ coincidence experiment has been performed at the Inter University Accelerator Centre (IUAC), New Delhi. A brief description about the experimental details and some preliminary results are presented.

Experimental Methods

An isotopically pure ^{159}Tb target (abundance $\approx$ 99.9 %) of thickness $\approx$ 1.79 mg/cm^2 was bombarded by ^{16}O^{7+} (E$_{Lab}$ $\approx$ 4-7 MeV/A, beam current $\approx$ 3 pnA) beam delivered from the 15 UD-Pelletron accelerator. The target thickness was measured by α-transmission method. This technique is based on the measurement of the energy lost by 5.487 MeV α particles (^{241}Am source), while passing through the target material. The experiment was carried out by using Gamma Detector Array (GDA) coupled to the Charged Particle Detector Array (CPDA). The GDA consists of 12 Compton-suppressed HPGe detectors at angles of 45^0, 99^0 and 153^0 with respect to the beam direction, with four detectors arranged at each of these angles along with a CPDA consisting of 14 Phoswich detectors housed in a scattering chamber arranged in the form of two truncated hexagonal pyramids. All 14 detectors of the CPDA are divided into three angular segments. There are 4 detectors at forward angles (F) (10^0 - 60^0), 4 detectors at backward angles (B) (120^0 - 170^0), and 6 detectors angled sideways (S), that is, between 60^0 and 120^0 , symmetric around 90^0, covering nearly 90% of the to-

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tal solid angle so that the angular distribution of charged particles in about a 4π arrangement may be recorded. In the present experiment, two groups of α particles are expected to be detected by forward-angle CPDs: (i) the fusion-evaporation (CF) α particles and (ii) the ICF fast α particles of energy corresponding to the beam velocity. In front of each four forward-cone CPDs, aluminum absorbers of appropriate thickness were used to stop the evaporated α-particles. Hence, mainly the fast α-particles with energy greater than evaporated α-particles have been detected in the forward cone.

Measurements and Analysis

Events were collected with particle-γ coincidence given by six HPGe Compton suppressed detectors and 14 Phoswich detectors. It may be pointed out that singles spectra has also been recorded during the time of experiments for the identification of xn channels. In the first step, the complete fusion channels were identified from the background suppressed singles spectra. In order to increase the statistics, the gain matched γ-ray spectra of HPGe detectors were summed up. As a representative case, Fig. 1(a) shows the singles spectra, where the selection of the rotational band for ^{170}Ta residue has been obtained from the level scheme [5]. To look for the alpha channels, the multiplicity of charged particles and α-particles detected in the CPDA were recorded by defining the charged particle-γ coincidence. Further, through the gating conditions (CPDA forward with the γ spectrum), alpha channels populated via incomplete fusion have been identified. Figure 1(b) displays, the gated γ ray spectrum in coincidence with the particle detectors placed forward with respect to beam direction. The level scheme used for the identifying ^{167}Lu($\alpha 4n$) rotational band was taken from [6]. The intensities of γ-rays of the identified bands has been used to obtain the yield of populated residues as a function of observed spins. These spin distribution measurements will give detailed information about the involvement of angular momentum associated with CF and ICF processes. Analysis of the data is in progress. Further details of the analysis will be presented.

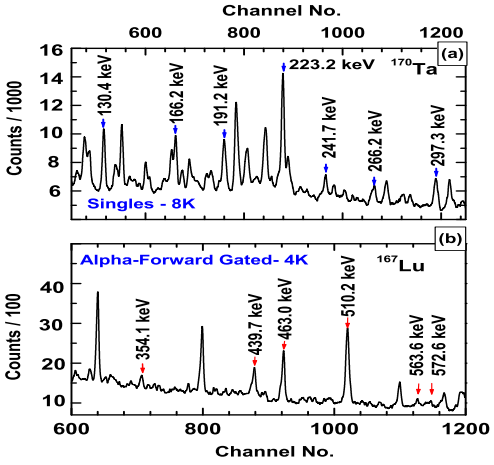

FIG. 1: Typical γ-ray spectra (a) singles (b) forwarded α-gated, at 100 MeV beam energy.

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