Beam energy dependence of light mass transfer in $^{16}O+^{89}Y$ reaction

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Introduction

Reactions involving incomplete mass transfer continue to be an active area of investigation [1-5] due to the complexity of the mechanism of such reactions involving quasi-elastic transfer, incomplete fusion (ICF) or massive transfer and deep inelastic collisions (DIC). Contribution from these reactions is expected to depend on the beam energy and entrance channel mass asymmetry. At beam energy close to the entrance channel Coulomb barrier, a systematic change in the angular distribution of projectile like fragments is observed showing the increasing nuclear contribution with increasing mass transfer [1,4]. The deeper interpenetration for large mass transfer channels also leads to a rapid fall in their cross sections with decreasing beam energy close to the barrier [5]. Cross sections for light mass transfer channels fall less rapidly indicating their formation in the peripheral collisions at energies close to the entrance channel Coulomb barrier. At higher beam energies the angular distributions for such channels involving light mass transfer also become forward peaked indicating deeper interpenetration of projectile and target nuclei. Study of these aspects in different reactions is important for understanding the contribution from peripheral and dissipative mechanisms in reactions involving incomplete mass transfer. Studies have been carried out to investigate the reactions involving incomplete mass transfer in ^{19}F induced reactions on different targets [4,5].

In the present work we present the results of PLF measurements in $^{16}O+^{89}Y$ reaction at E_{lab}=62.2 and 83.5 MeV. The focus of this paper is the beam energy dependence of N PLF formed in light mass transfer reactions. Elastic scattering measurements were carried out to get information about the grazing angle and total reaction cross section.

Experimental details

Experiments were carried out at BARC-TIFR pelletron accelerator, Mumbai. Elastic scattering and PLF measurements were carried out using Si detector based E-ΔE telescopes in the forward hemisphere. Self supporting target of ^{89}Y of thickness 1.1 mg/cm^2 was used for the experiments. A monitor detector was kept at 20^0 to detect the elastically scattered beam particles for the normalization for beam current and target thickness.

Results and discussion

Fig. 1 shows the elastic scattering data for $^{16}O+^{89}Y$ reaction at E_{lab}= 62.2 and 83.5 MeV. Solid line is the fit using the code SNOOPY. Fig. 2 shows N kinetic energy spectra at E_{lab}= 62.2 and 83.5 MeV. The kinetic energy spectra show two components namely direct transfer component (sharp peak) and quasi-elastic component (broader peak). As can be seen from the figure that the collisions leading to the formation of N become more dissipative at higher beam energy, reflected as increased lower

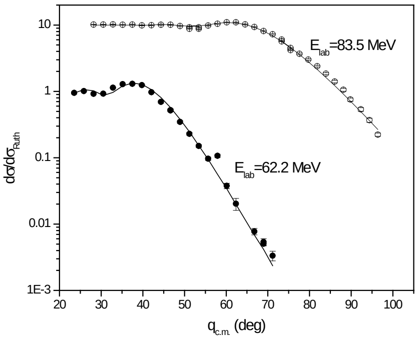

Fig. 1: Elastic scattering data for $^{16}O+^{89}Y$ reaction.

energy tailing in the kinetic energy spectrum at the higher beam energy. The lab kinetic energy spectra of N at different angles were integrated to obtain the lab angular distribution, which were transformed into centre of mass (CM) frame of reference using average N kinetic energy in CM frame of reference. The CM angular distribution of N is shown in Fig 3 as open circles. In order to obtain the angular distribution for direct transfer, areas under the corresponding peak (most intense peak selected at the higher beam energy) are separately plotted as filled circles. It can be seen from the figure that, at lower beam energy, angular distribution for the direct transfer component matches with that for the total N, both peaking close to the grazing angle. This indicates that the collision trajectories leading to the formation of N are mostly peripheral in nature. At higher beam energy, the angular distribution for total N differs from that for direct transfer which still peaks close to grazing angle, as expected for peripheral collisions. Angular distribution for total nitrogen has a forward peaking component, which can be attributed to the contribution from collision trajectories with lower impact parameter. For such collision trajectories, nuclear force will play a larger role leading to the forward peaking of the angular distribution. Theoretical calculations will be carried out to compute the Kinetic energy spectra of N for comparison with the experimental data.

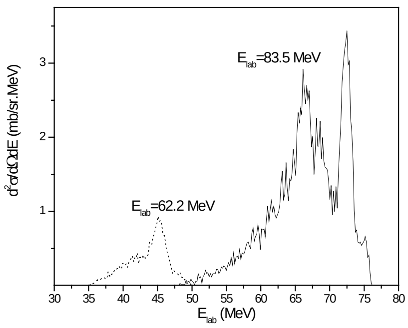

Fig. 2: Lab kinetic energy spectra of N.

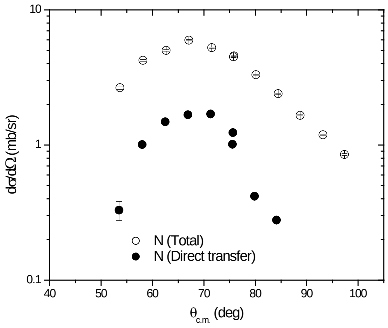

Fig. 3: CM angular distribution of N at E_{lab}=62.2 MeV .

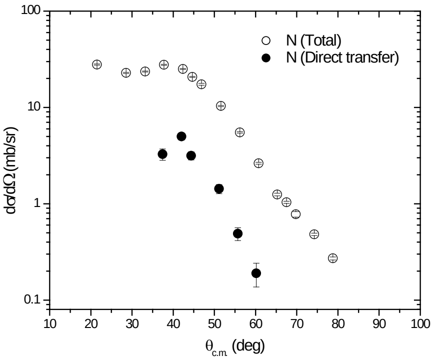

Fig. 4: CM angular distribution of N at E_{lab}=83.5 MeV .

In summary, kinetic energy spectra and angular distributions of PLFs were measured in $^{16}O+^{89}Y$ reaction. Analysis of the data indicated the contribution from more dissipative, lower impact parameter trajectories for light mass transfer channels with increasing beam energy.

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