Measurement and analysis of some excitation functions in heavy-ion induced reactions: A case of ^{18}O + ^{51}V system

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Introduction

In recent years the role of incomplete fusion (ICF) in heavy ion induced reactions at low bombarding energies has been in extensive discussion among theoreticians as well as experimentalists. The ICF reactions were first observed by Britt and Quinton [1] in the bombardment of heavy target by heavy ions at energies just well above the coulomb barrier. These reactions are of paramount importance because at energy close to the coulomb barrier, provide very detailed information for the studies of nuclear structure and nuclear dynamics. Further the ICF reactions are quite specific due to complex nature of incomplete mass transfer and its dependence on various entrance channel parameters like type of projectile, energy of projectile, transfer of input angular momentum (ℓ), deformations of the interacting nuclides, mass-asymmetry and α-break up energy (Q_α). The recent studies [2-4] show significant contribution of ICF at projectile energies just near and above the fusion barrier. At low projectile energies (~ 3 – 7 MeV/A), the ICF reaction dynamics is not well understood and hence needs more study and more experimental data. Also for most of the recent studies α-cluster structure beams have been used. The motivation of present study is to understand the behavior of ICF with neutron rich non alpha cluster projectile at relatively low bombarding energies.

In the present work, we have measured the excitation functions (EFs) of various evaporation residues for ^{18}O+^{51}V system in the energy range 3-6 MeV/A. To study of projectile structure and entrance channel effect on ICF, present results have also been compared with our earlier results obtained for ^{16}O+^{51}V system [5]

Experimental Details

The experiment has been carried out at 15UD Inter-University Accelerator Centre (IUAC), New Delhi (India) using General Purpose Scattering Chamber (GPSC) facility. The self supporting targets of V^{51} (each of thickness ≈ 1.61 mg/cm^2) and the aluminum catcher foils of thickness 1.45-1.49 mg/cm^2 were prepared by rolling technique. One out of two stacks contain-

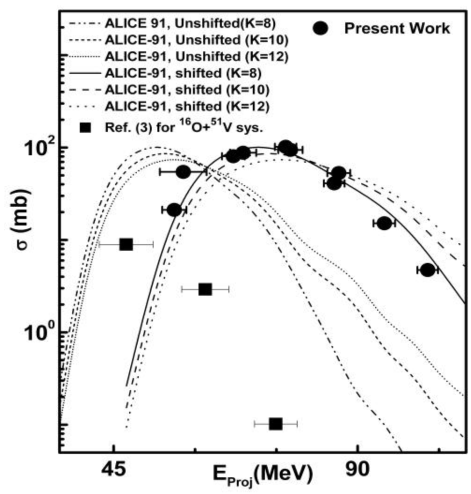

Fig. 1: Experimentally measured excitation function (EFs) and theoretical prediction of code ALICE-91 of ^{65}Ga along with measured EFs for ^{16}O+^{51}V system.

-ing six target-catcher foil assemblies was irradiated by $^{18}O^{7+}$ beam of energy ≈ 105 MeV for ~ 8.10 hrs while the other stack containing four target-catcher foil assemblies was irradiated by $^{18}O^{6+}$ beam of energy ≈ 88 MeV for ≈10 hrs. The beam current was ≈15 nA at 105 MeV and ≈30nA at 88MeV as measured by a Faraday cup installed behind the target-catcher foil assembly. The activities induced in individual target-catcher foil assembly were followed using pre-calibrated HPGe detector coupled with CAMAC based CANDLE data acquisition system developed by IUAC. The various evaporation residues have been identified by their characteristic decay γ-rays and confirmed by their half life measurements.

Results and Discussion

The excitation functions (EFs) of different evaporation residues have been measured in the energy range 3-6 MeV/A. The experimentally measured EFs are compared with theoretical predictions as obtained from the code ALICE-91 [12]. In code ALICE-91, incomplete fusion (ICF) and the angular momentum effects have not been taken into account. So the estimated energy shift in excitation function due the angular momentum effect has been calculated by using the expression for nuclear rotational energy $E_{rot} \approx (m_P/M_T)E_{lab}$, where m_P, M_T are the projectile mass and target mass and E_{lab} is the incident projectile energy. As representative case the experimentally measured EFs along with theoretical prediction for ^{65}Ga and ^{61}Cu radio isotopes are shown in Fig. 1&2. From Fig. 1 it can be seen that measured excitation function are in well agreement with the theoretical predictions corresponding to K = 8 (level density parameter a = A/K). However for ^{61}Cu via - α4n channel (Fig.2) an enhancement over theoretical predictions has been observed which indicates that ^{61}Cu is not only populated via CF but ICF is also contributing for the production of this isotope. The EFs for ^{65}Ga obtained through the interaction of ^{16}O with ^{51}V [5] have also been shown in Fig.1. it can be seen that the results with ^{18}O are much higher as compared with ^{16}O which may be due to effect of projectile structure as ^{18}O is two neutron rich than ^{16}O .

Conclusions

The experimentally measured EFs for xn/pxn channels for the present system have found to be be in good agreement with theoretically calculations indicating their production via CF process however a significant enhancement over theoretical predications for α -emitting channels is accredited due incomplete fusion of projectile with target. It is also observed that the ICF reactions get influenced by projectile structure along with the incident projectile energy. The detail of the work will be presented at time of symposium.

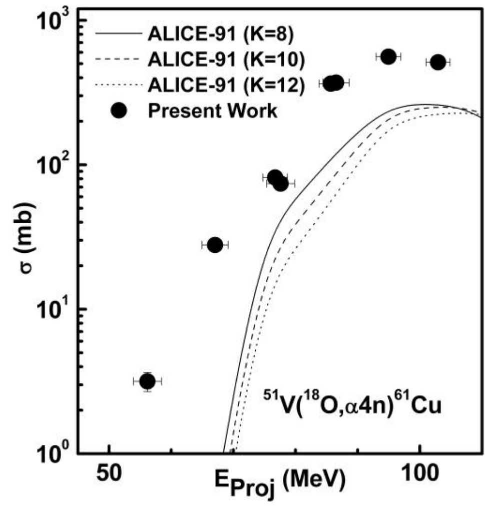

Fig. 2: Experimentally measured excitation functions (EFs) and theoretical prediction of code ALICE-91 for ^{61}Cu.

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