Effect of entrance channel in ^{16}O + ^{51}V interactions

Munish Kumar[1, 2]*, Avinash Agarwal[2], S. Prajapati[2], Sunil Dutt[3], Kamal Kumar[3], R. Kumar[4], I. A. Rizvi[3], and A. K. Chaubey[5]
[1]*Deptartment of Physics, KCMT, Bareilly-243001, INDIA*
[2]*Deptartment of Physics, Bareilly College Bareilly-243005, INDIA*
[3]*Deptartment of Physic, AMU Aligarh - 202002, INDIA*
[4]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, INDIA*
[5]*Physics Department, Addis Ababa University, Ethiopia*
* *Email: munish85physics@gmail.com*

Introduction

Nuclear reaction Physics research has entered a new era with the developments of accelerator technology in which heavy ions (HI) have been used as the projectile. These developments have improved our understanding and knowledge of mechanism involved in heavy fusion reaction at energies near and above the coulomb barrier of the reaction. These reactions are so important because at energy close to the coulomb barrier provide very detailed information for the studies on nuclear structure as well as nuclear dynamics. The earlier study [1, 2] shows that incomplete fusion (ICF) process starts competing with the complete fusion (CF) at projectile energies just near and above the coulomb barrier. Britt and Quinton [3] were observed first time the ICF reactions. The incomplete fusion reactions is a dynamic area of investigation 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 aim of this work is to investigate the dependence of ICF on different entrance channel parameters. This work is the extension of our previous study [4]

Experimental Details

This experiment was performed at 15UD Inter-University Accelerator Centre (IUAC), New Delhi (INDIA) by using the General Purpose Scattering Chamber (GPSC) facility. The experimental procedure, target preparation and description of data analysis used in this paper are similar to the previous paper [4].

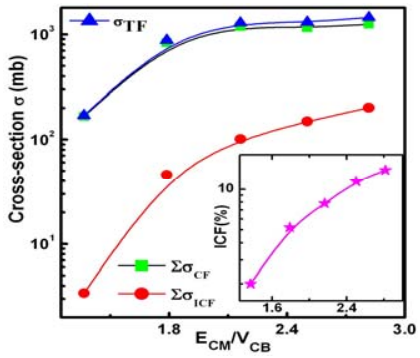

Fig. 1: The total fusion cross-section (σ_{TF}), Complete and incomplete fusion cross-section (σ_{CF} & σ_{ICF}) and in inset the probability of incomplete fusion are plotted as a function of reduced incident projectile energy (E_{CM}/V_{CB}).

Results and Discussion

In evaluating the $\sum\sigma_{ICF}$, $\sum\sigma_{CF}$ and σ_{TF}, where $\sum\sigma_{ICF}$ is the sum of incomplete fusion cross-section, $\sum\sigma_{CF}$ is the sum of complete fusion and σ_{TF} is the total fusion cross-section, we use the same formulation as in Ref. [5]. Now in order to study the dependence of ICF on different entrance channel parameters, the probability of ICF ($\%F_{ICF}$) at different projectile energies has been calculated by using the relation $F_{ICF}(\%) = (\sum\sigma_{ICF}/\sigma_{TF})\times100$. As the probability of ICF is a measure of relative strength of ICF to the total fusion. So these calculated values of F_{ICF} are plotted as a function of reduced incident projectile energy (E_{CM}/V_{CB}) as shown in Fig. 1. The probability of ICF is found to increase with the increase in projectile energy. The probability of ICF for the present system have also been

plotted in Fig. 2, along the two system ^{20}Ne +^{51}V [6] and ^{12}C+^{51}V [7].

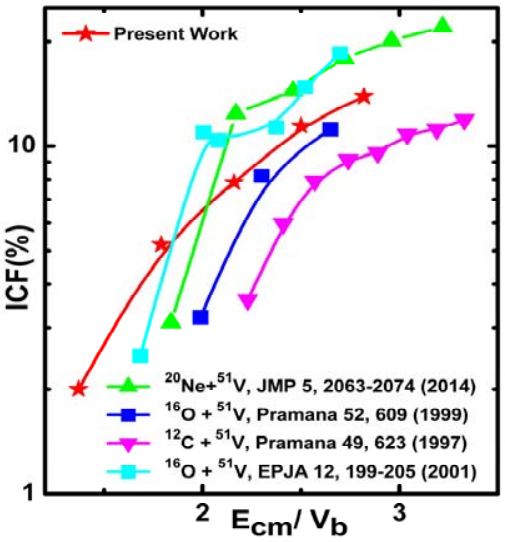

Fig. 2: The probability of ICF fraction as a function of reduced incident projectile energy compared with other study for same system and two other systems ^{20}Ne+ ^{51}V & ^{12}C+^{51}V

From Fig. 2, it can be seen that the F_{ICF} for the present work approximately same with the value of F_{ICF} evaluated by M. Ismail [7] at higher energy and at some energy with S. Mukherjee [8]. The data points suggest that the probability of incomplete fusion (F_{ICF}) is more for ^{20}Ne+^{51}V and less for ^{12}C+^{51}V system as compared to the ^{16}O+^{51}V system. This indicates that the probability of ICF also depend upon the projectile. At same projectile energy ^{20}Ne induced reaction possesses highest ICF probability than the ^{16}O and ^{12}C induced reaction for the same target ^{51}V. This difference in F_{ICF} may be due the projectile structure effects and may be due the α-Q value of the projectile. To validate this aspect of α-Q value, the probability of ICF (F_{ICF}) for present work with the available work [6, 7] at three relative velocities 0.078C, 0.084C & 0.090C has been deduced and plotted with V_{rel}/C as shown in Fig. 3. The calculated α-Q values for three systems ^{20}Ne+^{51}V, ^{16}O+^{51}V & ^{12}C+^{51}V are -4.73 MeV, -7.16 MeV and -7.37 MeV respectively. From the data presented in Fig. 3, the F_{ICF} is found to be less for larger α-Q value projectile, which is consistent with the previous studies [1, 2] and it can be conclude that α-Q value is an important entrance channel parameter.

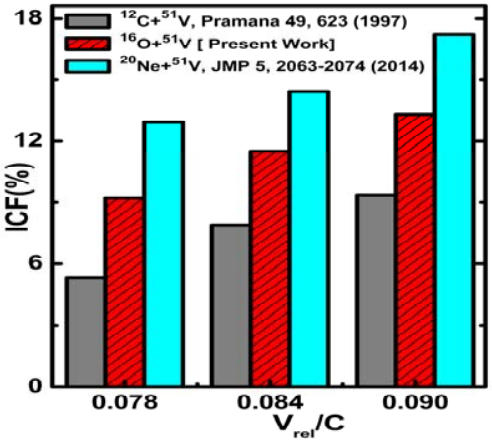

Fig. 3: Comparison of $\%F_{ICF}$ as a function of relative velocity Vrel/C for ^{20}Ne+^{51}V, ^{16}O+^{51}V and ^{12}C+^{51}V systems

Conclusions

During the analysis it has been found that the ICF reaction influenced by projectile structure along with the incident projectile energy and α-Q value of the interacting partners. The probability of in complete fusion ($\%F_{ICF}$) is found to increase with the increase in projectile energy. The fraction of ICF for the projectile having large α-Q value has been found decrease. The detail of the work will be presented at time of symposium.

References

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