Role of fusion fission process on fragment emission mechanism in $^{32}S+^{12}C$ reaction

R. Pandey[1*], C. Bhattacharya[1], S. Kundu[1], K. Banerjee[1], S. Manna[1], T. K. Rana[1], J. K. Meena[1], T. Roy[1], A. Chaudhuri[1], Md. A. Asgar [1], V.Srivastava[1], A.Dey[1], M.Sinha[1], G. Mukherjee[1], P.Roy[1], T.K.Ghosh[1], S.Bhattacharya[#1],A. Srivastava[2], K. Mahata[2], S.K.Pandit[2],P.Patle[2] , S.Pal[3], V. Nanal[3]

[1]*Variable Energy Cyclotron Center 1/AF, Bidhan Nagar Kolkata, India,*
[2]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA,*
[3].*Tata Institute of Fundamental Research, Mumbai - 400085, INDIA*
[#]*Raja Rammana Fellow*
* *email:* ratnesh@vecc.gov.in

Introduction

In recent years several studies have been made to understand the fragment emission mechanism in light heavy ion collisions [1–2]. These fragments are found to be emitted from projectile breakup, deep-inelastic, transfer and orbiting, to fusion–fission processes; structure of the nuclei play a significant role in some of the cases. The fragment emission from the compound system ^{44}Ti produced by the reaction ^{32}S+^{12}C at 280 MeV incident energy has been studied [3], where the dominant reaction mechanism was found to be symmetric splitting followed by evaporation. A large deformation has been observed in the study of light charged particle (LCP) emission from the same composite ^{44}Ti* produced by ^{16}O (76, 96, 112 MeV) + ^{28}Si [4] . The aim of present experiment was to study the fragment emission mechanism from the compound system ^{44}Ti produced via the reaction ^{32}S + ^{12}C at 200 MeV incident energy.

Experimental Details

Experiment has been carried out using 200 MeV $^{32}S^{+14}$ from BARC-TIFR Pelletron-Linac facility, Mumbai. The $^{32}S^{+14}$ beam was bombarded on self-supported ^{12}C target of thickness ~390 μg/cm^2 to produce the composite ^{44}TI*. The fragments (3≤Z≤7) have been detected using two ΔE-E-E [Si Strip-Si strip-CsI (Tl))] telescopes [5]. The calibration of the telescopes have been done using ^{229}Th (α source), the distance between target and detector was ~22.4 cm. The inclusive energy distributions of various fragments produced in the reaction have been measured in backward angular range

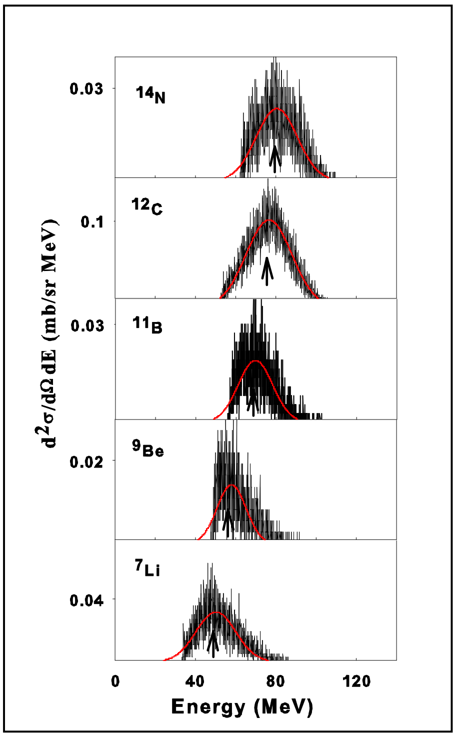

Fig: 1. Energy distribution of various fragments obtained at $\theta_{\lambda ab}$ =21.6^0, solid lines show Gaussian fit.

~16^0 – ~28^0 which corresponds to 40^0-~80^0 in c.m frame because of the inverse kinematics. The energy spectra for the fragments ^{7}Li, ^{9}Be, ^{10}B, ^{12}C and ^{14}N obtained at an angle of 21^0 are shown in Fig.1. It is seen that the energy spectra of these fragments are typically Gaussian in shape and their centroid corresponds to the expected kinetic energy for the binary break up obtained from the Viola systematic [6]. The Gaussian fit so obtained are shown by solid lines in Figure 1, with centroids shown by solid arrows.

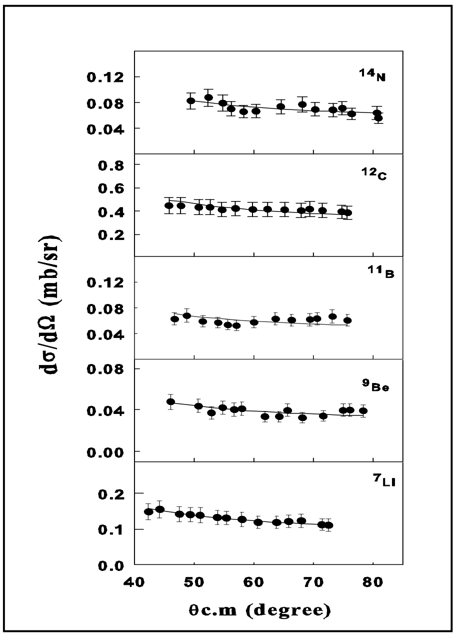

Fig: 2. Angular distribution of different fragments as a function of c.m. angle.

The differential cross section for these fragments were obtained by integrating the respective energy distributions under the fitted Gaussian. The c.m angular distributions ($d\sigma/d\Omega$) of these fragments have been displayed as a function of c.m angle in Fig.2. The transformations from laboratory to c.m. system have been done assuming a two body kinematics averaged over the kinetic energy distribution. The angular distribution of fragments are found to follow ~1/sinθ dependence in c.m. frame (shown by the solid lines in Fig. 2) which is characteristics of the fission like decay of equilibrated composite system.

The angular variation of the average Q value of each fragment provides information on the degree of equilibrium. The variation of average

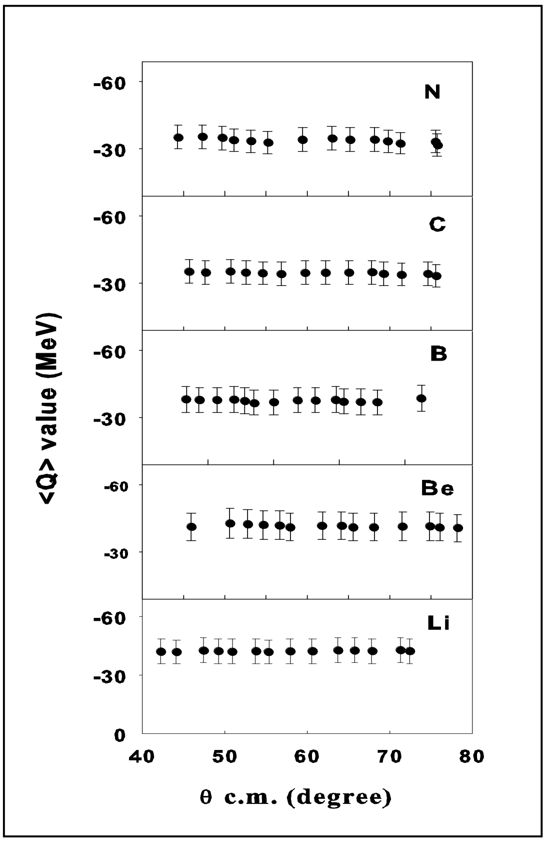

Fig: 3. Average < Q > value of the fragments plotted as a function of c.m. angle

Q value, <Q>, with c.m angle for the fragments are shown in Fig. 3. It is observed that <Q> value for all the fragments are independent of centre of mass emission angles, which further suggest that the fragments are emitted from completely equilibrated source. Further analysis is in progress.

References:

[1] C.Bhattacharya *et.al.* PRC 72, 021601(R) (2005)
[2] S. Kundu *et al.*, PRC **87**, 024602 (2013).
[3] R.Planeta, et.al PRC **34**, 512 (1986).
[4] P. Papka *et al.*, Acta Physica Polonica B, **34** (2003)2343
[5]R.Pandey et.al DAE symposium of Nuclear Physics , 59, 614, (2014).
[6] V. E. Viola *et al.*, Phys. Rev. C **31**, 1550, 1985