Kinetic energy spectra and angular distributions of projectile like fragments in $^{13}C+^{93}Nb$ reaction

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Introduction

In the recent past, the study of nuclear reactions involving incomplete mass transfers between projectile and target has been studied to investigate the role of parameters like entrance channel mass asymmetry, beam energy, angular momentum, target and projectile structure [1,2]. Several experiments have been carried out where it has been observed that projectile structure plays an important role for the enhancement of some specific reaction channels [3]. Apart from the complete fusion

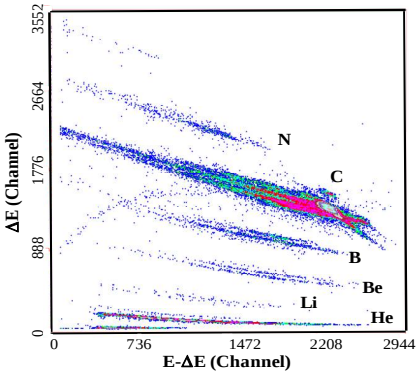

Figure 1: A typical 2D spectrum of PLFs formed in $^{13}C+^{93}Nb$ at 65 MeV

of the projectile with the target there are different transfer/pick up mechanisms like quasi elastic transfer (QET) or incomplete fusion (ICF) [4]. There are not many studies on the investigation of target structure in transfer / incomplete fusion reactions. It is also important to identify the different states of the PLFs and target like products which are involved in various transfer channels. With an objective to investigate the role of target structure in governing the transfer/pick up reaction mechanisms, kinetic energy spectra and angular distributions of the projectile like fragments (PLFs) were measured in $^{13}C+^{93}Nb$ reaction at 65 MeV beam energy.

Experimental details

Experiments were carried out in BARC-TIFR Pelletron-LINAC facility, TIFR, Mumbai, with ^{13}C beam of 65 MeV energy. A self supporting target of ^{93}Nb was used for the experiment. Online detection of the outgoing PLFs for various reaction channels were done by using silicon based E-ΔE telescopes. Two monitor detectors were used at $\pm 20^0$ for the normalization of beam current and target thickness. Online measurements were covering the angular range of 20^0 to 70^0.

Results and Discussions

From the E-ΔE 2D spectra, different PLFs were identified. Figure 1 shows a typical 2D

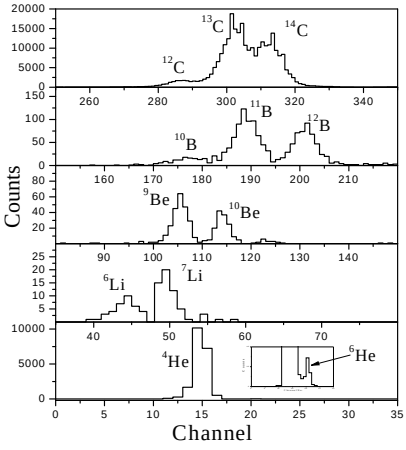

Figure 2: Y axis projection of Particle identifier spectra

spectrum of the PLFs which are formed in $^{13}C+^{93}Nb$ reaction. A 'Y' axis projection of the Particle identifier (PI) spectrum is shown in Figure 2 where different PLFs are identified. In $^{13}C+^{93}Nb$ reaction, 1p+2n pick up channel (corresponding to the formation of ^{90}Zr with N=50) was not observed as

was observed in $^{12}C+^{93}Nb$ reaction where close shell configuration of ^{90}Zr playing an important role resulting in the enhancement of ^{15}N yield. This observation suggests that projectile structure also plays an important role in observing the effect of target structure. From the kinetic energy spectra of the PLFs, different excited states of the PLFs and target like products (TLFs) were identified. In one proton pick up process the dominant reaction channel involved in the formation of ^{14}N as PLF is the first excited state (2.31 MeV) along with ^{92}Zr in the ground state, where as in the case of one proton striping channel, population of higher excited states

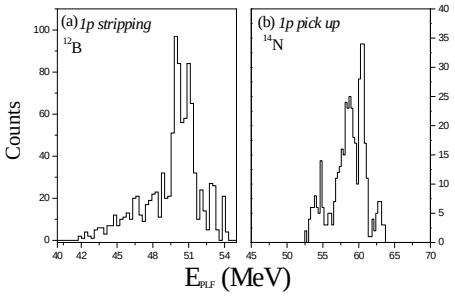

Figure 3. Kinetic energy spectra of (a) ^{12}B formed in 1p stripping and (b)^{14}N formed in 1p pickup in $^{13}C+^{93}Nb$ reaction at 65MeV energy

of both the PLF and TLF is dominating. It was also observed that in the Kinetic energy spectra (Figure 3) for one proton stripping is having long tail indicating more energy dissipation.

Center of mass (CM) angular distributions of some of the PLFs is shown in figure 4. As seen from the figure with increasing mass transfer the angular distributions become more and more forward peaked, indicating that the projectile target overlap increases with increasing mass transfer.

Conclusion

Online measurements of kinetic energy spectra and angular distribution of PLFs were carried out in $^{13}C+^{93}Nb$ reaction. The 1p+2n pick up channel leading to ^{90}Zr, a proton shell closed residue was not observed indicating that the projectile structure is also an important factor for observing the effect of target structure. It was observed that the one proton transfer channel is more dissipative compared to one proton pick-up channel. The systematic forward peaking of angular distributions of the PLFs with decreasing mass indicated increase in the overlap of the projectile and target with increasing mass transfer.

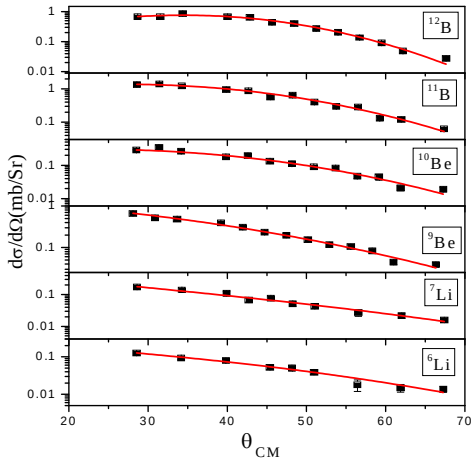

Figure 4. PLF angular distribution in $^{13}C+^{93}Nb$ reaction

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