Cluster emission studies in $^{28,29}Si^*$

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Introduction

Study of fragment emission mechanism has been a topic of contemporary research for the last few decades in nuclear physics. There are several processes like inelastic transfer, projectile breakup, fusion-evaporation, fusion-fission, deep inelastic process etc which are responsible for the production of fragments in the light heavy-ion collision [1-8]. Although the energy damped yields of the fragments are well explained by the fusion-fission process, a few exceptions have been observed when α-clustered nuclei are present in the entrance channel or exit channel or both. These reactions tend to show an enhancement in the yields over and above the statistical model prediction and/or resonance like excitation function in a few outgoing channels. This has been attributed to the competitive role played by the deep inelastic orbiting process which has a strong memory of entrance channel and influences outgoing channels around the entrance channel [5-8]. Apart from that recently it has been observed that α-clustering can also influence certain exit channels away from the entrance channel in a fusion-fission like process [9]. So it will be quite interesting to study the energy relaxed cluster emission from a composite formed at the same excitation through α-like and non α-like reaction channels. With this motivation detailed study of the two reactions $^{16}O + {}^{12}C$ and $^{20}Ne + {}^{9}Be$ forming the composites $^{28,29}Si^*$ have been performed and will be discussed in this conference.

Experimental Details

The experiment has been performed using 162 MeV ^{16}O and 193 MeV ^{20}Ne ions from K130 Cyclotron facility in VECC, Kolkata. The targets being used were ^{9}Be of thickness ~1.9mg/cm^2 and ^{12}C of thickness ~100μg/cm^2. The beam energies were chosen in such a manner that the composites $^{28,29}Si^*$ were formed at the similar excitation energy (~86 MeV).

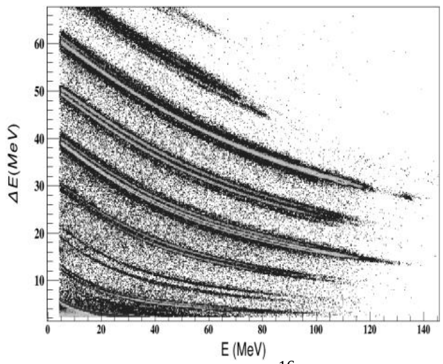

Fig. 1 ΔE Vs. E plot for ^{16}O (162 MeV) + ^{12}C reaction

The emitted fragments have been detected using two telescopes, each consisting of ~ 50μm ΔE single-sided silicon strip detector (SSSD) (16 strips, each of dimension 50mm × 3mm) and ~1030μm E DSSD and backed by 4 CSI(Tl) detectors of thickness 6 cm.

Typical band structure obtained for different fragments detected in the telescope at an angle 16^o are shown as ΔE Vs. E plot in Fig.1 and Fig.2 for $^{16}O + {}^{12}C$ and $^{20}Ne + {}^{9}Be$ reactions respectively. A good isotopic separation in each band is prominent in these figures. The inclusive energy distributions of the isotopes of the fragments ranging from Z=3 to Z=6 were measured in the angular range of 15^o to 36^o with typical angular resolution of ~1^o.

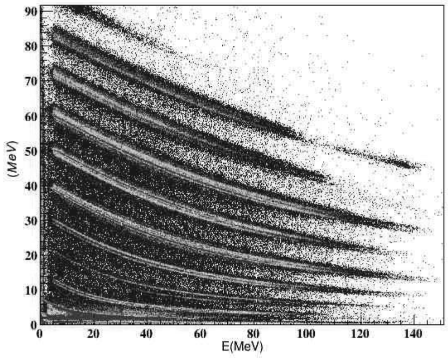

Fig. 2 ΔE Vs. E plot for ^{20}Ne (193 MeV) + ^{9}Be reaction

Data was collected on event-by-event basis using a VME-based on-line data acquisition system. The systematic errors in the data have been estimated to be ~15% arising from the uncertainties in the measurements of target thickness, solid angle and the calibration of current digitizer. The calibration of telescopes was done using elastically scattered ^{20}Ne and ^{16}O ions from ^{197}Au target and ^{229}Th 5-α source.

Analysis and Discussion

Typical inclusive energy spectra of isotopes of Li and Be fragments at 16^{o} are shown in Fig.3 for the two reactions. The expected kinetic energies for the fission fragments were obtained from the Viola systematics corrected by the corresponding asymmetry factors [10] and are shown by arrows in Fig. 3. It is observed that the energy distributions are nearly Gaussian in shape and the centroids lie exactly at a value predicted by Viola systematics, indicating that fragments are emitted from a fully energy relaxed composite. This is expected for both fusion-fission and orbiting process. To know the exact mechanism, one has to do the angular distribution of the fragments. Also to see the effect of clustering on fragment emission, isotopic yield ratios for both the systems have to be compared with the statistical model prediction. Further analysis is going on to decipher the exact mechanism of the fragmentation for this system.

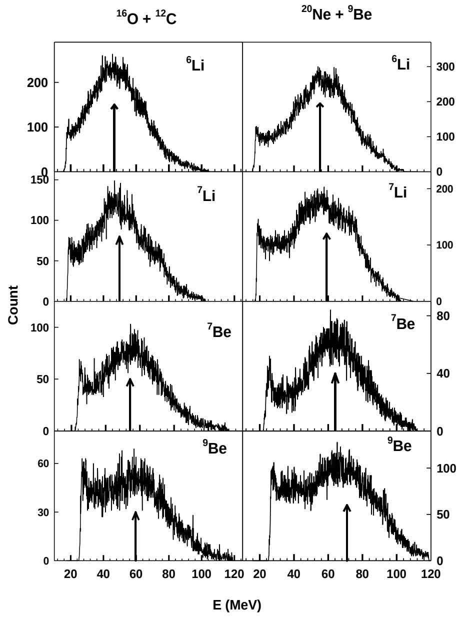

Fig. 3 Energy distributions of Li and Be isotopes for the ^{16}O + ^{12}C and ^{20}Ne + ^{9}Be reactions

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