Isotopic effects in fragment emission studies in low energy light ion reactions

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Extensive efforts [1, 2] have been made to understand the fragment emission mechanism in light-heavy ion reaction at low energy. Inelastic transfer, projectile breakup, fusion-evaporation, fusion fission, deep-inelastic process etc. are the main processes by which fragments are emitted at these energies. In most cases, fragment emission is explained by the above reaction mechanisms, with the exception for reactions involving α-clustered nuclei, e.g, ^{20}Ne + ^{12}C, ^{24}Mg + ^{12}C, ^{28}Si + ^{12}C etc. For these systems, enhancement in the yield and/or resonance-like excitation function in a few outgoing channels (around the entrance channel) have indicated the role played by deep inelastic orbiting process in fragment emission. Isotopic yield of fragments is considered to be an important tool to study such entrance effects; however, such data are scarce at low energies.

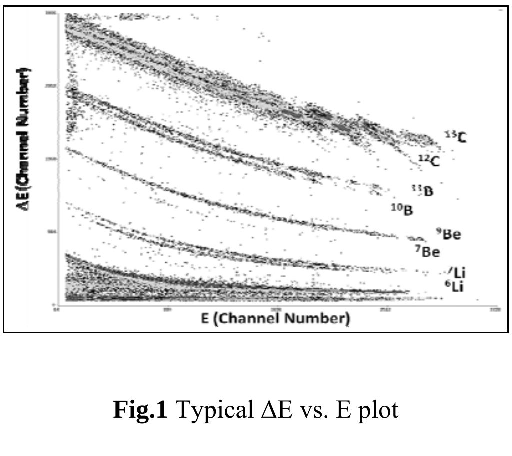

Fig.1 Typical ΔE vs. E plot

Here we report our measurement of fragment emissions in ^{12}C (80 MeV) on ^{12}C and ^{13}C (78.5MeV) on ^{12}C reactions. The present experiment has been done with the motivation to see if there is any isotopic dependence of fragment yield in these two reactions.

The experiment has been performed at BARC-TIFR 14UD Pelletron, Mumbai, using 80 MeV ^{12}C and 78.5 ^{13}C projectiles on ^{12}C target (self supporting, thickness~70μg/cm^2). The beam energies have been chosen to produce same excitation of the Compound nucleus in both the cases. 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 6cm CSI(Tl) detectors. A VME-based on-line data acquisition system was used for the collection of data on event-by-event basis. Typical beam current used for the experiment was ~10nA. Typical charge resolution obtained in this experiment has been illustrated in the ΔE vs. E plot displayed in Fig.1. Well separated bands for different isotopes of each fragment have been obtained. The systematic errors in the data have been estimated to be ~15%. These include the errors 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 ^{12}C ion from ^{209}Bi target and ^{229}Th α source. Inclusive energy distributions for the various fragments ($3 \leq Z \leq 5$) have been measured in the angular range of 14^0 to 36^0.

Typical inclusive energy distribution (angle $\theta_{lab} = 14^0$) of different isotopes of the fragments Li, and Be obtained in the two reactions have been shown in Figs. 2 and 3 by solid and dotted lines respectively.

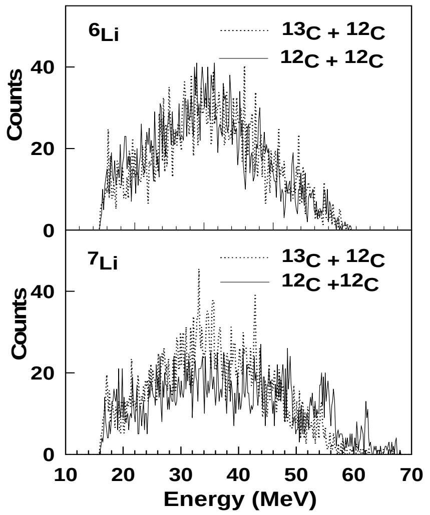

Fig. 2 Normalised Energy distributions of Li isotopes

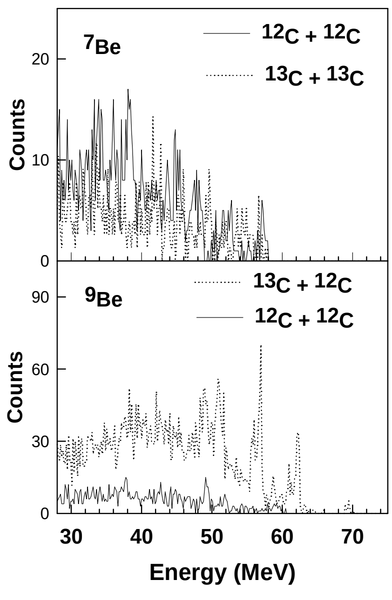

Fig. 3 Same as Fig. 2 for Be isotopes

It is seen from Fig. 2 that, the energy distribution of ^{6}Li and ^{7}Li obtained in ^{12}C + ^{12}C reactions exactly match with those obtained in ^{13}C+ ^{12}C reaction except for the transfer channel states. However, from Fig. 3 it is seen that the though the energy spectra obtained for ^{7}Be in both cases, are nearly similar, there is a large variation in the yield of ^{9}Be in these two reactions.

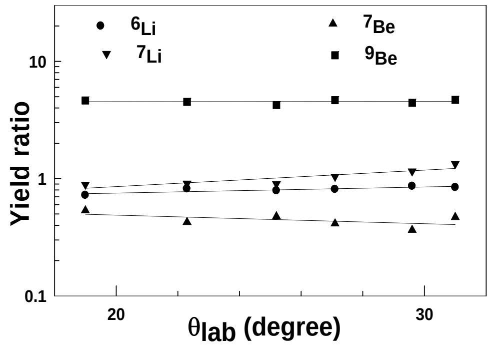

Fig. 4 Angular variation of the isotopic yield ratios of Li and Be obtained in ^{13}C + ^{12}C and ^{12}C +^{12}C reactions.

The ratio of the energy integrated yields of each fragment isotopes obtained in the two reactions at various angles has been plotted in Fig. 4. It is seen that, over the whole angular range, there is no significant difference in the yield of Li isotopes obtained in these two reactions. However, the yield of ^{9}Be for the reaction ^{13}C + ^{12}C is nearly four times larger than that obtained in ^{12}C +^{12}C reactions, at all observed angles. This may be due to much less Q-value is required for binary splitting into ^{9}Be + ^{16}O in case of ^{13}C + ^{12}C reaction. Further analysis is in progress.

References

[1] S. J. Sanders, *et al.*, Phys. Rep. 311 (1999) 487 and references therein.

[2] S. Kundu, *et al.*, DAE Symp. On Nucl.Phys. 55, 326 (2010) .