Effect of isospin on light charged particle emission

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Introduction

The effect of N/Z asymmetry on various nuclear parameters has been a topic of interest recently as they shed light on the properties of nuclei away from the valley of stability. The equilibrium yields of fragments emitted from neutron rich composites can be an observable to study this effect. The comparison of energy spectra of the emitted fragments with standard statistical model based on Hauser-Feshbach (HF) framework [1] leads to unravel the inconsistency, if any, present for these kinds of systems. However, one of the most critical inputs in the HF calculations of nuclear reaction cross sections is nuclear level density. Recently, from the study of neutron evaporation spectra, it has been observed that the level density parameter depends on N and Z independently rather than a simple function of A, and its value reduces as N/Z changes from the value around the valley of stability [2]. Therefore, it will be interesting to see whether there is any effect on the evaporation light charged particle spectra for nuclei away from the stability line. With this motivation, the proton and α emission from the composites $^{62,68}Zn^{*}$ have been studied in the present work.

Experimental details

The experiment has been performed with ^{4}He ion beam from K-130 cyclotron, VECC, Kolkata on ^{58}Ni and ^{64}Ni targets of thicknesses ~450μg/cm^2 and ~500μg/cm^2 respectively. Three sets of beam energies were chosen to produce the composites at similar excitation energies (E_x). The critical angular momenta (l_{cr}) for fusion are also similar for each set. The detailed experimental parameters are given in Table 1.

Table 1: Experimental parameters

Beam	Target	E_{lab} (MeV)	E_x (MeV)	l_{cr} (ħ)
^{4}He	^{58}Ni	35.0	36.1	14
	^{64}Ni	32.7	36.1	14
	^{58}Ni	45.0	45.5	15
	^{64}Ni	42.7	45.5	16
	^{58}Ni	52.4	52.4	17
	^{64}Ni	50.0	52.4	17

The light charged particles emitted from the reactions mentioned above have been identified using one Si-strip telescope (T1), consisting of ΔE, ~20μm single sided silicon strip detector (SSSD, 16 vertical strips, each of area 0.3cm X 5cm) and E, ~1mm double sided silicon strip detector (DSSD, 16 strips per side, front: made up of vertical strips and back: horizontal strips), at one side and two silicon detector telescopes (T2: ΔE ~50μm + E ~500μm and T3: ΔE ~100μm + E~5mm) on the other side of the beam direction. The distance of the strip telescope from the target was ~15cm, whereas the same for the other two telescopes was ~20cm. The actual setup is shown in Fig.1

Fig. 1 Experimental set up

Analysis and results

The calibration of the detectors were done using ^{229}Th 5-α source along with elastic peaks obtained from scattering of ^{4}He ion from ^{197}Au target. The typical ΔE-E particle identification spectrum obtained from T2 is shown in Fig. 2.

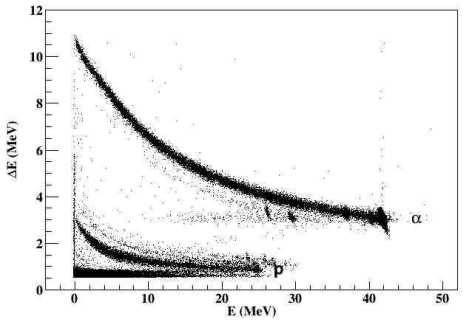

Fig.2 Particle identification in telescope T2

The proton and α band are quite distinct and have been extracted for further analysis. The projection of these bands on the energy axis gives the energy spectra which have been normalized with respect to the total incident beam charge, target thickness and the detection solid angle. The proton energy spectra thus obtained for two systems at excitation energy ~45.5 MeV is shown in Fig.3 at an angle 120^{o} in laboratory. Fig.4 shows the energy spectra of proton and α for the two systems at θ_{lab}=50^{o}. It has been observed that the yields of light charged particles are less in ^{4}He + ^{64}Ni system compared to the ^{4}He + ^{58}Ni system. The degree of decrement in yield is higher for proton than α.

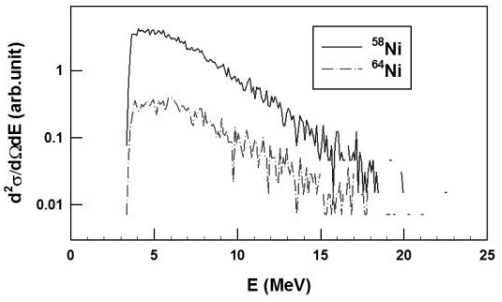

Fig. 3 Energy spectra of proton at θ = 120^{o}

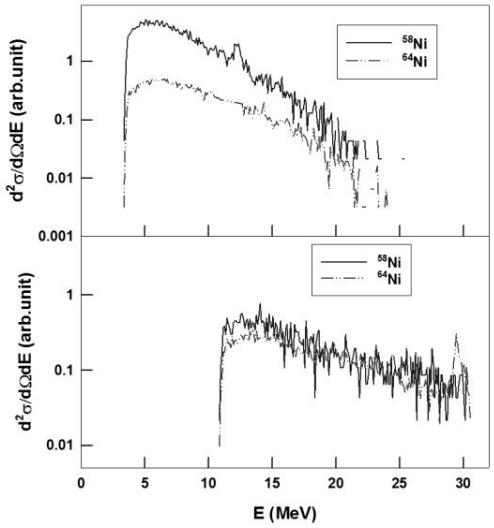

Fig. 4 Energy spectra of proton (top) and α (bottom) at θ = 50^{o}

Discussion

The yields of the light charged particles have been extracted at back angles to avoid contamination from direct reactions. The energy spectra of the proton and α for the ^{4}He + ^{58}Ni and ^{4}He + ^{64}Ni reactions have been compared for one set of energy and show more yield for the former reaction. However, the data needs to be further compared with the statistical model predictions to infer about the results obtained in this work. The data of other sets of energies will also be analysed. The final results will be discussed in the conference.

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References

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