Effect of α-clustering in the emission of light charged particle in α + ^{28}Si, ^{27}Al

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Introduction

The clustering in nuclei is an interesting subject of study in recent years [1]. It can be studied in many ways, resonance decay [2], γ decay from the giant dipole resonance [3], intermediate mass fragment emission [4], light charged particle (LCP) [5] etc. LCPs emitted at various stages of de-excitation cascade reflect the behavior of the hot composite and the reason behind their deformation. Comparing the slope of the energy spectra with statistical model calculations, we can have an idea about the reason of the deformation of the composite i.e. whether the deformation is due to angular momentum or due to clustering. In this paper we have reported the preliminary result of our recent study on emission mechanism of LCPs in α-clustered system α + ^{28}Si and non- α clustered system α + ^{27}Al at 48 MeV.

Experiment

The experiment was performed using accelerated α beam from the K130 cyclotron at VECC, Kolkata. The charged particles, emitted from the reactions α (48MeV) + ^{28}Si (natural silicon having 92.23% of ^{28}Si) and α (48 MeV) + ^{27}Al, were detected using a three-layered charged particle telescope consisting of silicon strip detectors [6] of thickness ΔE(47μm) - E(1034μm) - SE(1035μm) which covered an angular range of 111^0-138^0. The distance between the ΔE detector and the target was ~ 9 cm. The energy spectra of LCPs were measured in coincidence with γ-multiplicity, detected by two BaF_2 multiplicity detector array each having 25 detectors [7]. These arrays were kept at the top and bottom of the target at mutual distance of ~12 cm keeping the target at the mid position. Calibration of the charge particle telescopes were done using ^{229}Th α source.

Results

The inclusive centre of mass (c.m) energy spectra of *p*, *d*, *t* and α, obtained at θ_{lab} = 130^o, emitted in reactions α (48MeV) + ^{27}Al and α (48MeV) + ^{28}Si have been shown by left and right

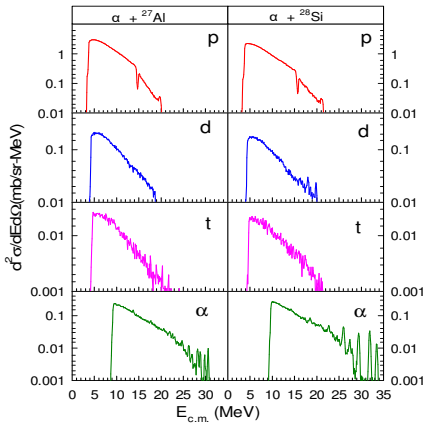

Fig.1 Typical c.m. energy spectra of *p, d, t* and α emitted from reactions (a) α + ^{27}Al (b) α + ^{28}Si at θ_{lab} = 130^0.

panel in Fig.1, respectively. The centre of mass angular distributions of the energy-integrated cross sections have been shown in Fig. 2. The solid circles are the experimental data and solid lines correspond to the fit to the data obtained using Eq. $\frac{d\sigma}{d\Omega} \propto \frac{C}{sin\theta_{c.m.}}$. Average Q-values for different charged particles were obtained from two body kinematics using mean energy of the particles. The <Q>-value distributions are shown in Fig. 3 and all are independent of c.m. emission angle.

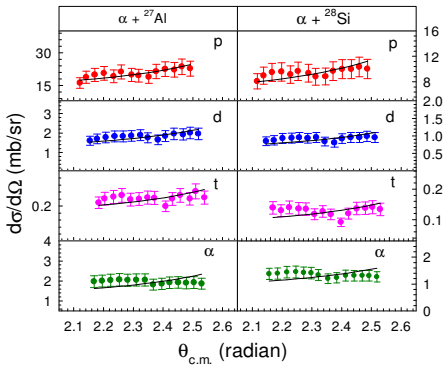

Fig. 2 Centre of mass angular distribution of p, d, t and α. The solid circles are the experimental data and solid lines correspond to the fit to the data obtained using Eq. $\frac{d\sigma}{d\Omega} \propto \frac{C}{sin\theta_{c.m.}}$.

Discussions

The inclusive energy spectra of LCP emitted by fusion-evaporation process follow maxwellian distribution. In the measured energy spectra, there are sharp cuts in the lower energy part because of finite thickness of ΔE detector. The measured energy spectra were compared with maxwellian function which reproduced the data well. The angular distributions of the LCPs were fitted well with the equation, $\frac{d\sigma}{d\Omega} \propto \frac{C}{sin\theta_{c.m.}}$. It is a characteristic of the emission from an equilibrated composite nucleus. Independence of <Q> on c.m. angle is another signature of emission of LCP from an equilibrated composite nucleus. The energy spectra of LCP need to be compared with statistical model prediction to get information about the deformation of the composite nucleus from which the LCP are emitted.

Summary

The emission mechanism of evaporated particles proton, deuteron, tritium, alpha have been studied in backward angles in α clustered system α + ^{28}Si and non-α clustered system α + ^{27}Al at 48 MeV. The energy spectra, angular distribution and <Q>-value distribution shows that the LCPs are emitted by fusion-evaporation process. Statistical model (CASCADE) calculation is being done to see whether the deformation produced in the composite ^{32}S* is due to angular momentum or due to α clustering and will be presented during symposium. γ-multiplicity gated energy spectra is being studied to see the effect of angular momentum on the particle emission. Analysis is in progress.

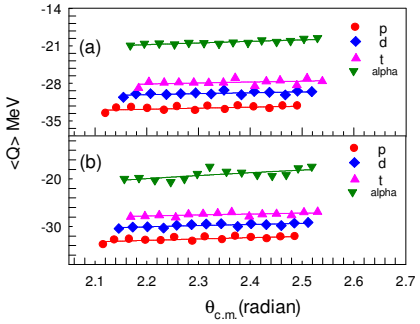

Fig.3 <Q>-value distribution of LCPs emitted in reaction (a) α + ^{27}Al (b) α + ^{28}Si

References

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