Study of Single nucleon transfer in $\alpha + {}^{12}C$ reaction

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Introduction

Nucleon transfer reactions are of great significance for understanding the nuclear structure both for direct reaction studies as well as for production of nuclear states. Single nucleon pickup, in which nucleons are transferred from projectile to target and stripping reactions, in which nucleons are transferred to target from projectile, are extensively used to infer the occupation probabilities of single nucleon states**.** Transfer reactions are simplest to interpret when either the initial and final state of the target nucleus has spin zero and when the conditions are such that the transition from the initial and final states occurs to a good approximation in a single step. This happens when the interaction between the projectile and target nucleus is weak and can be treated in first order perturbation i.e. in Born approximation. The theoretical methods such as the distorted-waves Born approximation (DWBA) has facilitated the use of transfer reactions to make angular momentum assignments from the shapes of angular distributions, and to deduce spectroscopic factors from the magnitudes of measured cross sections. In this paper, we have reported the measurement of angular momentum distribution and calculation of the spectroscopic factor for one nucleon transfer reaction in $\alpha + {}^{12}C$ reaction.

Experimental Setup

The experiment was performed at the Variable Energy Cyclotron Centre K130 cyclotron with 60MeV alpha beam. The target was self supported foils made from natural carbon having thickness of 90 μg/cm^2. The measurement was carried out inside a scattering chamber in beam line 2. In our experiment we have used three element telescope, a single sided 52 μm thick Si (ΔE) strip detector, followed by a double sided 524μm Si (E) strip and 4CsI detectors of thickness 6cm for charge particle measurement. The single sides ΔE detector had 16 strips, each with dimension 50 mm x 3 mm and the double sided E detector of dimension 50 mm x 50 mm was subdivided into 256 pixels of dimension 3 mm x 3mm. The dimension of each CsI crystal was 25mm

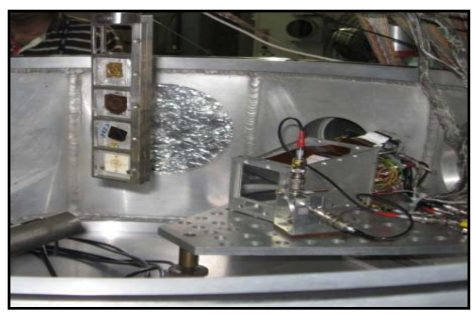

Fig.1 : Photograph of the experimental setup showing the target ladder and the three element telescope.

X 25mm.The distance between target and the centre of the front detector of the telescope was 19 cm. Because of rapid oscillations of the elastic scattering angular distributions, an angular resolution of ~1^o was desirable in our measurement. The angular resolution of our set up was slightly better than that. A VME based data acquisition system was used for the collection of data. Typical experimental setup is shown in Fig 1. A typical two dimensional spectrum of Si strip detector of thickness 524μm vs. CsI (Tl) is shown in Fig.2. In our experiment we have clearly identified the ground and first exited states of 13C and 13N.

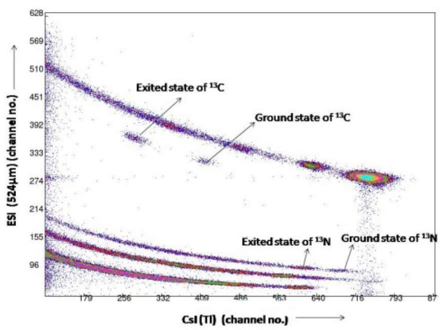

Fig. 2: Particle identification in telescope. Different populated states are indicted.

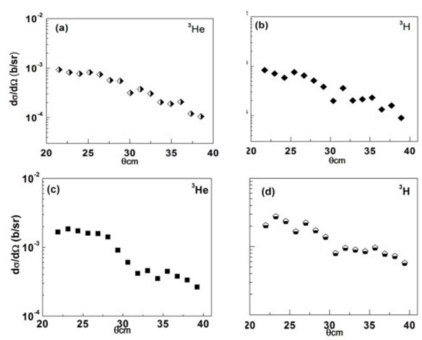

Fig. 3 (a, c) Angular distribution of ground and excited state of ^{13}C, and Fig. (b, d) ground and excited state of ^{13}N, respectively

Preliminary Results

We have measured the angular distributions of ^{3}He and ^{3}H for p and n transfer reaction cross section in ^{12}C (α, ^{3}He) ^{13}C and ^{12}C (α, ^{3}H) ^{13}N reactions. The analysis is based on the DWBA description considering these reactions as direct stripping processes. The aim of the experiment is to extract spectroscopic factors that can be compared to those determined from the analyses of related reactions or from shell-model calculations. Fig. 3 shows the extracted angular distributions of ^{3}He and ^{3}H in center of mass angle for ground and first exited states of ^{13}C and ^{13}N produced in reactions ^{12}C(α, ^{3}He)^{13}C and ^{12}C(α, ^{3}H) ^{13}N at $E_\alpha = 60$ MeV. The measured angular distribution for the reaction involving the ^{12}C nuclei exhibit a fall in differential cross section with appreciable oscillations in the small angle range.

Summary

The measured angular distributions of ^{3}He and ^{3}H from the (α, ^{3}He) and (α, ^{3}H) reactions for angles between 15^0 to 30^0 in lab at beam energy ~ 60 MeV has been investigated. DWBA calculation for the extraction of spectroscopic factor is in progress.

References

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