(α,^{3}He) and (α,^{3}H) transfer reaction studies at E_α=60 MeV

R. Pandey*[1], A. Dey[1], T. K. Rana[1], M. Biswas[2], T. K .Ghosh[1], C. Bhattacharya[1], S. Kundu[1], K. Banerjee[1], G. Mukherjee[1], P. Roy[1], J. K. Meena[1], V. Srivastava,[1] H. Pai[1], M.Gohil[1], S. Bhattacharya[1]
[1]*Variable energy Cyclotron Centre, Bidhan Nagar, Kolkata-700064,India*
email: *ratnesh@vecc.gov.in in

Introduction

The extraction of spectroscopic factors from single particle transfer reaction has been important both in testing various nuclear models and as a confirmation on reaction theories when the nuclear structure is well known. Our understanding of the structure of nuclei is largely in terms of an underlying architecture of the constituent nucleons occupying single-particle states in an average potential, a mean field. 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. Here we report optical model parameters of entrance and exit channels of α+^{12}C reaction from ECIS [1] and DWUCK [2] code. The calculated spectroscopic factors are in good agreement with shell model calculations.

Experimental details

The experiment was performed at VECC using 60MeV α beam from K130 cyclotron. The target was self supported carbon foil made from natural carbon having thickness of 90μg/cm^2. The angular distribution of both elastic and transfer channels were measured using a three element telescope, consisting of a single sided 52 µm thick Si (ΔE) strip detector, followed by a double sided 524µm Si (E) strip and 4CsI(Tl) detectors of thickness 6cm .

The detail of experimental setup was given in reference [3]. The angular resolution of our set up was ~0.9^0. For collection of data a VME based data acquisition system was used.

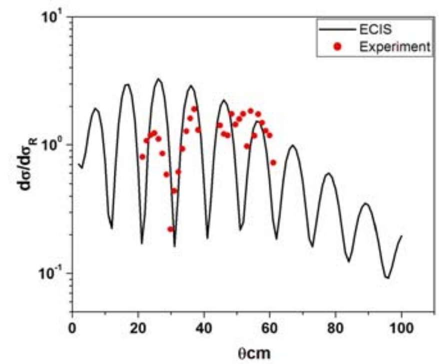

Fig.1: α - particle angular distributions by α+^{12}C elastic scattering at 60 MeV.

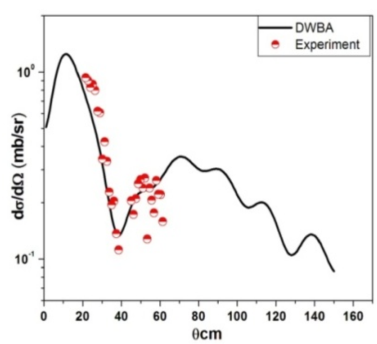

Fig.2: Angular distributions of helions from (α, τ) reaction on ^{12}C.

The measured differential cross section for elastic scattering [4] of α from ^{12}C target is shown in Fig. 1 (circles) along with the theoretical estimates (solid line) obtained by

ECIS code. The measured angular distributions of transfer channels, hilions and tritions from (α, τ) and (α, t) reactions are shown (circles) in Fig. 2 and Fig. 3 respectively along with the theoretical estimates (solid lines) obtained using DWUCK4.

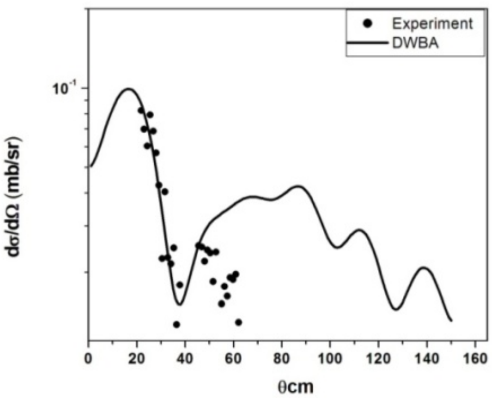

Fig.3: Angular distributions of tritons from (α, t) reaction on ^{12}C.

Reaction	V_o	R_o	a_o	V_I	R_I	a_I
$^{12}C(\alpha,\alpha)^{12}C$	140	1.28	.645	40.1	1.72	.445
$^{12}C(\alpha,\tau)^{13}C$	118	1.10	.800	12.2	1.60	.820
$^{12}C(\alpha,t)^{13}N$	116	1.00	.800	12.2	1.6	.820

Fig.4: Optical model parameters extracted for elastic and inelastic scattering by $\alpha+^{12}C$ interactions.

Results

The measured angular distributions of ^3He and ^3H from the (α, ^3He) and (α, ^3H) reactions for angles between 15^0 to 47^0 in lab at beam energy ~ 60 MeV has been investigated. The calculated angular distribution for the reaction involving the ^{12}C nuclei exhibit a fall in differential cross section with appreciable oscillations in the broad angular range. The optical model parameters for elastic channel are extracted using ECIS code and then analysis of (α,τ) and (α,t) reaction studies have shown that DWBA theory in zero range approximation is able to give the successful reproduction of the measured angular distributions. Fig. 4 Shows table of Optical model parameters extracted using ECIS and DWUCK4 codes.

Conclusion

The calculated spectroscopic factor for ground states of ^{13}C and ^{13}N (1.11 and 1.16) are in good agreement with that of shell model calculations. The observed hilion yield was ~10% grater then trition yield. The reactions are characterized by an angular momentum transfer ℓ =1 and spectroscopic factor deduced from best fits for both reaction types are in satisfactory agreement with the theoretical values.

References

[1] Jacques Raynal, Notes on ECIS94.

[2] P. D. Kunz, Zero range distorted wave born approximation.

[3] R. Pandey et .al. DAE Sympossium on Nuclear Physics, B91, 2011.

[4] G. Hauser et.al Nuclear Physics A 128, 81 (1969).

[2]*Department of Physics, HIT, Kolkata-107*