Study of (α,^{3}He) and (α,t) reactions on ^{27}Al at 50 MeV

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The study of one-nucleon transfer reactions provides valuable information on the nuclear structure. In recent years, there has been much interest in the study of transfer reactions. Here, we report the study of single-nucleon transfer reactions using ^{27}Al(α,^{3}He)^{28}Al and ^{27}Al(α,t)^{28}Si reactions at 50 MeV bombarding energy. From the inelastic scattering angular distributions of α + ^{27}Al reaction, an average β-value of 0.325 had been found at 50 MeV which is much smaller than the previously reported value [1]. On the other hand, the (α,^{3}He) and (α,t) reactions on ^{27}Al target were studied earlier at 65 [2], 80 [3] and 104 MeV [4], however, some ambiguity still persists in the reported results. To solve this discrepancy, we study the (α,^{3}He) and (α,t) reactions on ^{27}Al target at 50 MeV. We also try to measure the experimental ratio of the ^{3}He to triton yield.

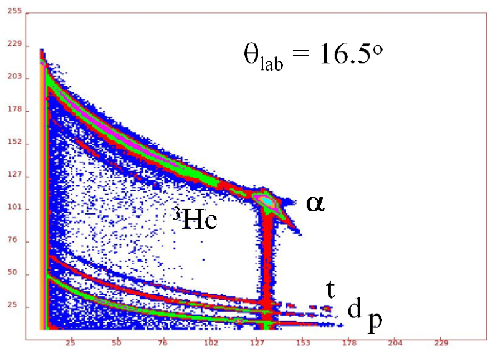

Fig. 1: Two dimensional ΔE-E plot using Si (500 μm) – CsI(Tl) combination for the α (50 MeV) + ^{27}Al reaction at the angle θ_{lab} = 16.5° .

The experiment was performed using the α-ion beam of energy 50 MeV from the Variable Energy Cyclotron at VECC, Kolkata. The target was self-supporting ^{27}Al foil (~ 225 μg/cm^2). The experimental details were given in Ref. [5]. A typical ΔE-E plot along with the corresponding α-particle spectrum at θ_{lab} = 16.5° is shown in Fig.1. The solid angle subtended by each strip in forward-angle was 0.58 msr. Well-separated peaks corresponding to different populated states of ^{28}Si, ^{28}Al and ^{29}Si are clearly visible in the excitation energy spectra. Calibration of the detectors was done with 2 states of ^{27}Al (0 and 2212 keV) from the α-spectrum, 2 states of ^{28}Si (0 and 1779 keV) from triton spectrum, 4 states of ^{29}Si (0, 1273, 2028 and 2426 keV) from d spectrum and 1 states of ^{28}Al (0 + 30 keV) from ^{3}He spectrum.

The elastic scattering angular distribution had been analyzed using the optical model potential. The search code ECIS94 [6] was used to perform the optical model calculations to obtain the parameters of the best fit potential. The experimental elastic scattering angular distribution is shown in Fig. 2 by solid points. The best fit with optical model potential parameters is shown in Fig. 2 by solid line. The best fit parameters are given in Table 1 with r_C = 1.31 fm, the Coulomb radius.

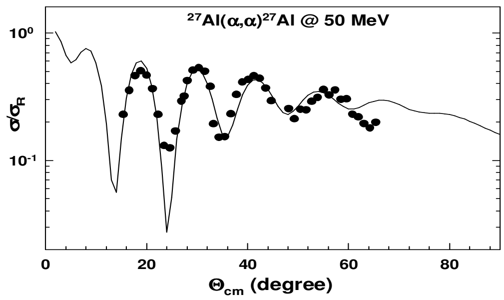

Fig. 2: Elastic scattering angular distribution for the α + ^{27}Al reaction at 50 MeV.

The finite-range DWBA calculations were performed using the computer code DWUCK5 [7] for the observed excited states up to 8.0 MeV in ^{28}Si and 2.3 MeV in ^{28}Al produced through the

$^{27}Al(\alpha,t)^{28}Si$ and $^{27}Al(\alpha,^{3}He)^{28}Al$ reactions, respectively, at 50 MeV. The distorted waves in the entrance and the excited channels were generated using the optical model potentials given in Table 1 and Table 2. Standard non-locality correction of $\beta = 0.2$ fm for α-particles and $\beta = 0.3$ fm for ^{3}He and tritons were used in the DWBA calculations.

Table 1: Best fit optical model parameters for α + ^{27}Al at 50 MeV.

Vo = 210.54 MeV	Ro = 1.195 fm	ao = 0.73 fm
Wv = 50.62 MeV	Rv = 1.195 fm	av = 0.73 fm
Ws = 1.55 MeV	Rs = 1.195 fm	as = 0.67 fm

Table 2: Optical model parameters used in the DWBA calculations for the exit channels ^{3}He + ^{28}Al and t + ^{28}Si [3].

Vo = 114.0 MeV	Ro = 1.15 fm	ao = 0.826 fm
Wv = 0.0 MeV	Rv = 0.0 fm	av = 0.0 fm
Ws = 75.2 MeV	Rs = 1.18 fm	as = 0.82 fm

The experimental cross section is related to the differential cross section calculated from DWUCK5 by the following relation:

$$\sigma^{\exp}(\theta) = \frac{2J_f + 1}{2J_i + 1} C^2 Sg\, \sigma^{DWUCK\,5}(\theta)$$

where J_f and J_i represent the total spins of the final and initial nuclei, C^2 is the isospin Clebsch-Gordon coefficient, and S and g are the heavy and light particle spectroscopic factors, respectively.

The DWBA calculation had been performed for the 11 states of ^{28}Si and 7 states of ^{28}Al. All the states are positive parity states, except the 6879 keV; 3^- states. The l-transfer was 0 or 2 for most of the states.

The experimental ratio of triton to ^{3}He yield had been calculated and it was about 1.26 which is opposite to the reported results [4].

More analysis is in progress.

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