Elastic scattering of alpha particles from ^{27}Al target

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At energies of a few tens of MeV α-particle elastic scattering angular distribution exhibits pronounced structure which usually varies smoothly with target mass and incident energy. The elastic scattering has been generally well described by the optical model potential in which the parameters of the potential have been found to vary smoothly with target mass (A) and bombarding energy (E_{lab}). However, there are cases of low energy α-scattering from light targets which show irregular variations with A and/or E_{lab} which may be due to compound nucleus or nuclear structure effects. This is particularly true for targets in the s-d shell.

Here we reported the α-particle elastic scattering angular distributions from ^{27}Al targets at various incident energies. The α-particle elastic scattering was studied earlier at 40 [1], 41 [2], 65 [3], 80 and 104 MeV however, the energy dependence of the optical model parameters was not studied yet.

The experiment was performed using 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). Both elastic and transfer channels were detected using two three element (Si-Si-CsI) solid state telescopes mounted on two arms of the scattering chamber which could move independently. Each telescope consists of a 50 μm ΔE single-sided Si-strip detector (16 horizontal strips of 3 mm width), 500 μm E/ΔE double-sided Si-strip detector (16 strips, width 3 mm, both side mutually orthogonal to each other) and two 6 cm CsI(Tl) detectors. A 6 mm slit was placed in front of each telescope and the data was collected only at the reaction plane. Well separated ridges corresponding to different particles as well as excited states are clearly seen in ΔE-E scatter plot (Fig. 1). The solid angle subtended by each strip is ~ 5 msr. The detectors were calibrated using elastically scattered α-ion from Au target and a Th-α source.

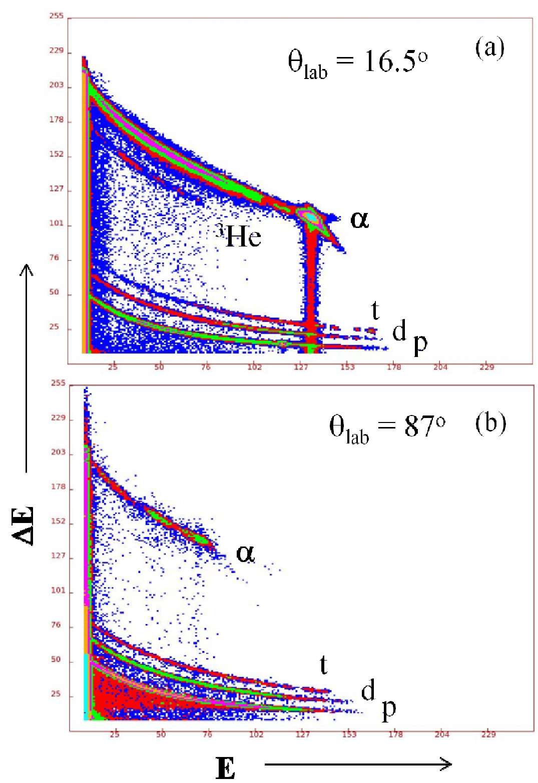

Fig. 1: Two dimensional ΔE-E plot using Si (500 μm) – CsI(Tl) combination for the α (50 MeV) + ^{27}Al reaction at the angle (a) θ_{lab} = 16.5° and (b) θ_{lab} = 87°.

The optical model analysis was carried out using the parametric Woods-Saxon forms for both the real and imaginary potentials. The phenomenological optical model potential used to describe the elastic angular distributions at each energy had the following form

$$U(r) = V(r; Vo,Ro,ao) + i[W_F(r) + W_D(r)] + V_C(r)$$

where V(r) denotes the volume type Woods-Saxon real potential, WF(r) is a volume type Woods-Saxon imaginary potential to simulate the fusion after penetration of the barrier and WD(r) is a derivative type Woods-Saxon imaginary potential to account for the absorption due to reactions occurring at the surface.

$V(r) = -Vo\ [1+ \exp(r-Ro)/ao]^{-1}$

$W_F(r) = -Wv\ [1+ \exp(r - Rv)/av]^{-1}$

$W_D(r) = -Ws\ [1+ \exp(r - Rs)/as]^{-1}$

The search code ECIS94 [4] has been used to perform the model calculations. In the present work, we will perform the optical model fitting for the energy 40 MeV [1], 50 MeV (our data) and 65 MeV [3] for the $\alpha + {}^{27}$Al reaction.

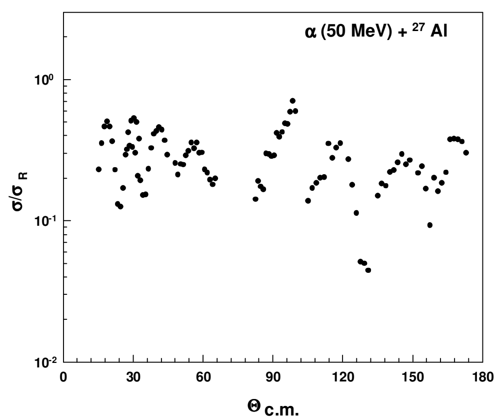

Fig. 2: Elastic scattering angular distribution for the α (50 MeV) + ^{27}Al reaction obtained in the present work.

In our calculation, we would take nine variable parameters described earlier.
Detailed analysis is in progress.

References

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