Elastic scattering angular distributions in ^{28}Si+ ^{197}Au, ^{209}Bi and ^{232}Th reactions at 179 MeV

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Introduction:

The elastic scattering between the projectile and target nuclei provides information about the nuclear interaction and matter distribution. In heavy-ion induced reactions involving light projectiles and heavy targets at incident energies around the Coulomb barrier, there is a dependence of the optical model parameters on the target-projectile structure and the beam energy [1].

It has been observed that there is anomalously large interaction cross-section for ^{11}Li induced elastic scattering reaction, which led the concept of "halo nuclei" [2]. This indicates that elastic scattering can also be used as a probe to investigate the nuclear matter distribution. In case elastic scattering reactions at energies near the Coulomb barrier, the real and imaginary parts of the optical potential gives the description of the nuclear system and the energy dependence of the optical model parameters for ^{6}Li + ^{116,112}Sn, has been reported earlier [3].

In the present work, we have studied the elastic scattering for ^{28}Si + ^{197}Au, ^{209}Bi, ^{232}Th systems to understand the effect of the target nucleus on the optical model parameters at energies above the Coulomb barrier.

Experimental details and results:

The experiment was performed using ^{28}Si beam from BARC-TIFR LINAC facility, Mumbai, India. The ^{28}Si beam of 179 MeV energy was bombarded on targets ^{197}Au (400 μg/cm^2), ^{209}Bi (500 μg/cm^2) and ^{232}Th (1.6 mg/cm^2). The elastically scattered particles and the projectile-like fragments, were detected by using two Silicon detector telescopes, consisting of ΔE (25 μm)–E detectors (300 μm). These telescopes were mounted at a distance of 26 cm from the target on a rotating arm inside the general purpose scattering chamber. A collimator with 5 mm diameter was placed in front of the telescopes. Another silicon detector of 300 μm thick was placed at an angle 15^o with respect to beam direction at a distance of 60 cm, having a collimator of 2.0 mm. This detector was used to measure Rutherford scattering events and for normalization of the angular distribution data, measured by the telescopes at various angles.

The elastic scattering angular distribution measurements have been carried out in a wide angular range from 30^0 to 130^0. The ratios of elastic to the Rutherford scattering cross sections have been plotted as a function of scattering angle ($\theta_{c.m.}$) for all the three systems as shown in Fig.2.

The optical model analysis of the elastic scattering data was performed using the SNOOPY8Q code [4]. In the fitting procedure the real and imaginary diffuseness parameters (a_o and a_w) were kept fixed for ^{28}Si + ^{197}Au,^{209}Bi systems and only the strength of real and imaginary potential parameters (V_o and W_s) were varied to obtain the best-fit of the experimental data. Over all, very good fits to the experimental data were obtained for both the systems as shown in. Fig.1. However, for ^{28}Si + ^{232}Th system, the diffuseness parameter 'a_o' was varied to a larger value, for obtaining the best fit to the experimental data. The potential parameter values for best fit and the total reaction cross section are given in Table-I. The best fitted optical model parameters requires a larger value of 'a_o' for the ^{28}Si + ^{232}Th system in comparison to the other two systems, which may be due to the large deformation of ^{232}Th target nucleus. Further detailed analysis with different form of the potential is being carried out and the results will be presented in the symposium.

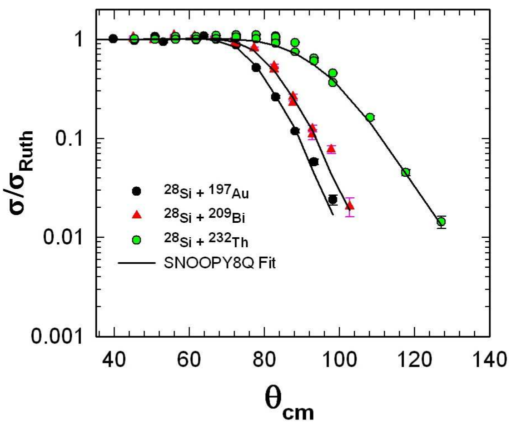

Fig.1: Elastic scattering angular distribution for the for ^{28}Si + ^{197}Au, ^{209}Bi, ^{232}Th systems at E_{lab} = 179 MeV. The solid lines are optical–model fits to the data using the SNOOPY8Q code.

TABLE-I: Optical model parameters obtained by fitting to experimental elastic differential cross section data using the SNOOPY8Q code in ^{28}Si + ^{197}Au, ^{209}Bi, ^{232}Th reactions.

System	V_o	W_s	a_o	a_w	σ_{tot} (mb)
^{28}Si + ^{197}Au	27.00	72.00	0.526	0.557	2100
^{28}Si + ^{209}Bi	35.23	86.70	0.526	0.557	1479
^{28}Si + ^{232}Th	20.02	72.16	0.686	0.557	1413

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