Search for improved global α-nucleus optical potential

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Reliable optical model potential parameters are required for the calculation of reaction cross sections with the α-particle in the entrance as well as exit channel. The low energy behavior of the α nucleus potential is crucial for estimating cross section of interest to astrophysics [1] and in the calculation of α decay of heavy nuclei. A number of parametrizations are available in the literature for the optical model potential. A complex potential was used by Huizenga and Igo [2] to calculate reaction cross sections for about twenty target nuclei for energies up to about 45 MeV. An extensive optical model analysis of elastic scattering of 24.7 MeV alpha particles for nuclei ranging from O to U was carried out by McFadden and Satchler [3]. A comprehensive review of alpha nucleus optical model can be found in Ref. [4].

The potential parameter obtained from elastic scattering at higher energies (>80 MeV) fails to describe either the low energy (<40 MeV) elastic scattering or the complete fusion data. The statistical alpha particle emission is underestimated by the optical model parameters which account for elastic scattering on the ground state nuclei. In the last decade, several approaches have been developed in order to solve questions which are sill open concerning the optical model analyses.

A simple prescription for α-nucleus opti-

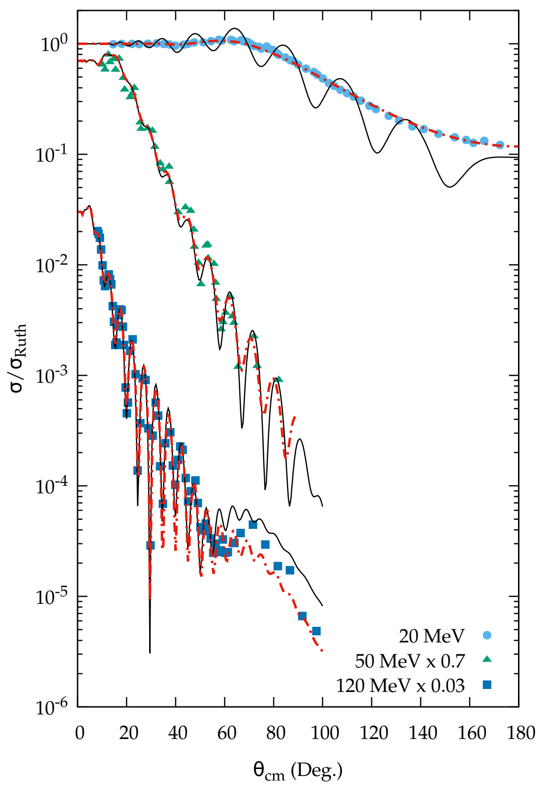

FIG. 1: The experimental α particle elastic angular distributions on ^{144}Sm target at various energies are compared with the calculated angular distributions using potential prescription of Kumar *et al.* [5] (the continuous line), modified prescriptions for energy dependence of imaginary volume integral from Demetriou *et al.* [6](the dot-dashed line).

cal potential valid for a range of energies (E)

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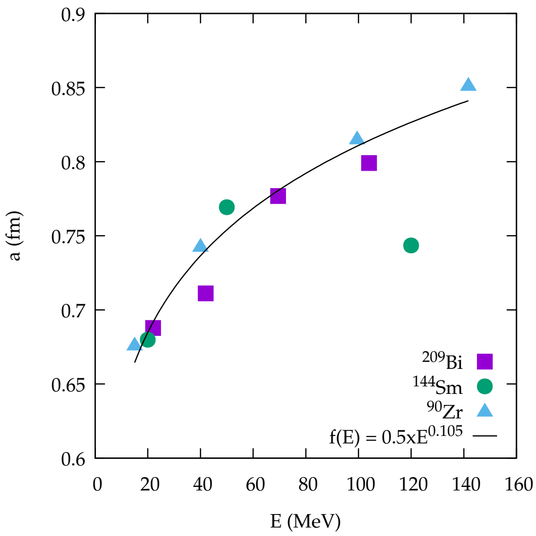

FIG. 2: The obtained energy dependence of the diffuseness parameter (a) of the real part of the optical model potential for ^{90}Zr, ^{144}Sm and ^{209}Bi targets.

starting from the Coulomb barrier to 140 MeV and nuclei with mass numbers (A) from 12 to 209 was prescribed by BARC group [5]. To obtain the parameters of the real and imaginary potentials of the Woods-Saxon volume form, the systematics of the volume integrals (J), $R_{2.4}$ and $S_{2.4}$ have been used. Here, $R_{2.4}$ and $S_{2.4}$ are the radius and slope where the potential strength is 2.4 MeV, respectively.

The above prescription fails to reproduce the experimental data at energies near the Coulomb barrier [7]. In the earlier work [8], we have investigated the reason for the discrepancy. It was observed that the predicted strength of the imaginary part (W_0) was very small, giving rise to the oscillation in the calculated elastic angular distribution at energies around the Coulomb barrier. The energy dependence of W_0 was suitably modified. Further, the best fit to the elastic scattering data around the Coulomb barrier energy could be obtained by slightly decreasing the value of the diffuseness parameter (a) of the real part. In the present contribution, we have investigated the energy dependence of the diffuseness parameter of the real part of the optical potential.

In this work, we have obtained the optical model parameters from the modified prescription [8]. Only the diffuseness parameter of the real part of the optical potential, which was found to be the most sensitive, was varied to fit the experimental angular distributions using the Fresco code [9]. The experimental angular distribution data were taken from EXFOR [10]. Fig. 1 shows the angular distribution data for ^{144}Sm at 20, 50 and 120 MeV in comparison with the optical model calculation using different optical model paramters. Similar calculations (not shown) were carried out for ^{90}Zr and ^{209}Bi target also. Fig. 2 shows the obtained energy dependence of the diffuseness parameter from the best fit to the experimental elastic angular distributions. As can be seen from the figure, the best fit value of ‘a’ follows a systematic trend. The observed trend could be reproduced with the expression a(E) = p$\times E^q$ with p = 0.5 and q = 0.105.

In summary, we have investigated the energy dependence of the diffuseness parameter of the real part of the optical model potential. The observed trend could be reproduced with a simple analytical expression. Details will be presented.

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