Improving global α-nucleus optical potential at low energies

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Alpha-nucleus potentials are very important for the calculation of reaction cross sections with alpha particles in the entrance or exit channel. The low energy behavior of the alpha nucleus potential is crucial for estimating cross section of interest to astrophysics [1]. There are many parametrizations available in the literature for the optical model potential. Huizenga and Igo [2] used a complex potential to calculate reaction cross sections for about twenty target nuclei for energies up to about 45 MeV. However, no data was fitted. McFadden and Satchler [3] did an extensive optical model analysis of elastic scattering of 24.7 MeV alpha particles for nuclei ranging from O to U. A comprehensive review of alpha nucleus optical model was also made by Singh and Shwandt [4]. In the last decade, several approaches have been developed in order to solve questions which are sill open concerning the optical model analyses. Potential obtained from elastic scattering at higher energies (>80 MeV) do not describe either the low energy (<40 MeV) elastic scattering or the complete fusion data, and the statistical alpha particle emission is underestimated by the optical model parameters which account for elastic scattering on the ground state nuclei.

BARC group [5] has proposed a simple prescription for α-nucleus optical potential valid for a range of energies (E) starting from the Coulomb barrier to 140 MeV and nuclei with mass numbers (A) from 12 to 209. The systematics of the volume integrals (J), $R_{2.4}$ and $S_{2.4}$, which are found to be well behaved with respect to E and A, have been used to determine the parameters of the real and imaginary potentials of the Woods-Saxon volume form. Here, $R_{2.4}$ and $S_{2.4}$ are the radius and slope where the potential strength is 2.4 MeV, respectively. It was recently pointed out that this prescription fails to reproduce the exper-

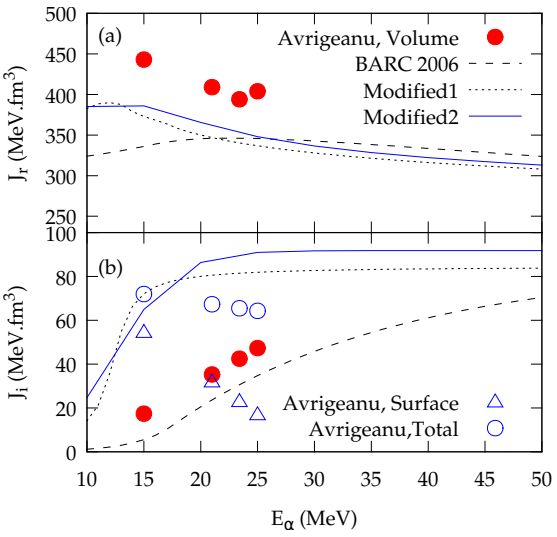

FIG. 1: Volume integrals (symbols) corresponding to the best fit to the experimental angular distributions [6] (Avrigeanu) are compared with those from Kumar *et al.* [5] (BARC2006, dashed line). Modified volume integral with energy dependence from Mohr *et al.* [7] (Mohr, dotted line) and Demetriou *et al.* [8] (Demetriou, continuous line) are also shown.

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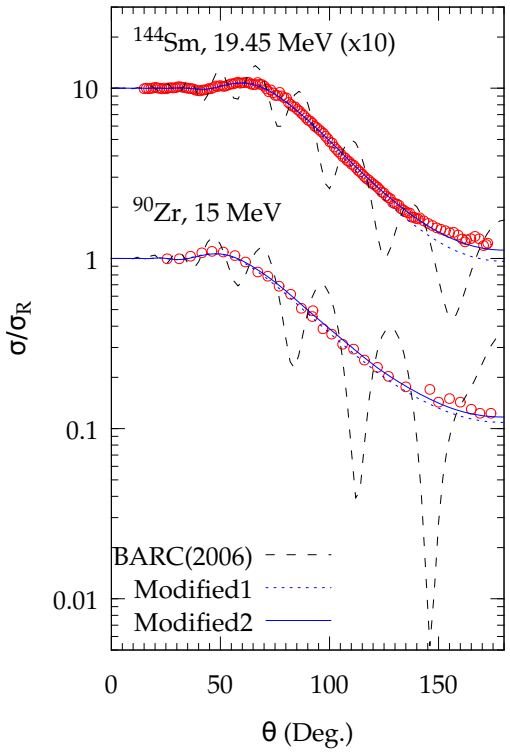

FIG. 2: The experimental elastic angular distributions are compared with the calculated angular distributions using potential prescription of Kumar *et al.* [5] (BARC2006), modified prescriptions with energy dependence for imaginary volume integral from Mohr *et al.* [7](Modified1) and Demetriou *et al.* [8](Modified2).

imental data at energies near the Coulomb barrier [6]. In the present work, we have investigated the reason for this discrepancy and looked for possible improvements.

As shown in the Fig. 1 and Table I, the prescribed value of the imaginary volume integral and the corresponding strength of the imaginary part of the potential are found to be very low at energies around the Coulomb barrier. This gives rise to oscillations in the calculated angular distributions at these energies. We have modified the energy dependence of the imaginary volume integral according to Mohr *et al.* [7] (Modified1), and Dimetriou *et al.* [8](modified 2)

The obtained potential paramenters were put in Fresco code [9] to calculate angular distributions. Experimental angular distribution data were taken from EXFOR [10]. Fig. 2 shows the angular distribution data for ^{90}Zr at 15.0 MeV and ^{144}Sm at 19.45 MeV in comparison with the optical model calculation using different optical model paramters.

TABLE I: Parameters of the Wood-Saxon potential for α + ^{90}Zr at E_α = 15 MeV corresponding to different prescription used (see text). The value of r_i = 1.235 fm for all the prescriptions.

	V_0 (MeV)	a_0(fm)	W_0	r_i(fm)	a_i (fm)
BARC2006	143.6	0.76	1.32	1.555	0.6
Modified1	159.4	0.70	17.1	1.555	0.6
Modified2	164.3	0.68	16.0	1.535	0.6

As can be seen from the table, the modified prescriptions gives larger strength for the imaginary part of the potential and removed the oscillations in the calculated angular distributions. Further, the best fit could be obtained by slightly decreasing the value of the diffuseness parameter of the real part. Details will be presented.

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