Alpha Optical Potentials of p-nuclei

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1. Introduction:

Nuclei heavier than iron(Z>26) are formed by neutron capture (s or r) processes. In nature there are 35 proton rich isotopes (^{74}Se-^{196}Hg) are not produced by s- or r-processes. Their natural abundances are 10 to 100 times small compared to the s- or r-nuclides, known as p-nuclides. They produced in the γ-induced reaction process via (γ,α),(γ,p) and (γ,n) reactions [1]. Reaction rates of (γ,α),(γ,p) and (γ,n) reactions determined from the reaction cross-sections. Direct γ induced reaction relevant in stellar environment. The γ-induced reaction cross-sections can be measured from cross-sections of inverse reaction using principle of detailed-balance. Measurement of (α,γ),(p,γ) reaction cross-sections by statistical model calculations are very sensitive to the choice of α or proton optical potentials. There are very few measurements that have extracted the optical potentials for p-nuclei targets. A. Ornelas et al. recently studied the α + ^{106}Cd elastic scattering and measured the optical potentials at E$_{lab}$= 16.1-27 MeV [2]. They used DDM3Y potential for real part and surface imaginary Wood-Saxon potential only at lower energy. Both volume and surface imaginary potentials used only for higher energy data to reduce χ^2 value. G.G Kiss et al. measured α-elastic scattering from ^{106,110,116}Cd nuclei at E$_{lab}$=16.1,19.6 MeV [3] and on ^{106}Cd at E$_{lab}$=16.1,17.7,19.6 MeV [4]. They also used microscopic folding model for real potential and Wood-Saxon form for imaginary potential.

In this work we study the α-elastic scattering of p-nuclei and determined the local optical potential parameters for α + ^{106}Cd using a Wood-Saxon form factor for both real and imaginary potentials. This is unlike to all of the previous measurements.

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2. Alpha nucleus optical potential for the present system:

The optical model potential is given by

$$U(r) = V_c(r) + V(r) + iW(r) \qquad (1)$$

V$_c$(r) is the coulomb potential. V(r) and W(r) are the real and imaginary part of the nuclear potential. V(r) and W(r) in Wood-Saxon form are

$$V(r) = V_o f_v(r)$$

$$W(r) = \left(W_v f_w(r) + W_s \frac{df_w(r)}{dr} \right)$$

where

$$f_i(r) = \frac{1}{1 + exp\frac{r-R_i}{a_i}} \qquad i = v, w$$

Where R_i and a_i are the radii and diffusivities respectively. V_o ,W_v , W_s are the potential depths of real, volume imaginary and surface imaginary respectively.

The experimental elastic scattering data of ^{106}Cd fitted using the optical parameter search SFRESCO [5].

3. Results and Discussion:

Local optical potential parameters of α + ^{106}Cd system calculated from measured angular distribution data in the energy range 16.1-27 MeV. In this system used volume Wood-Saxson potential for both real and imaginary part.

The SFRESCO [5] calculation for α + ^{106}Cd system at laboratory energy 19.6 MeV is shown by solid lines in FIG 1. The calculation

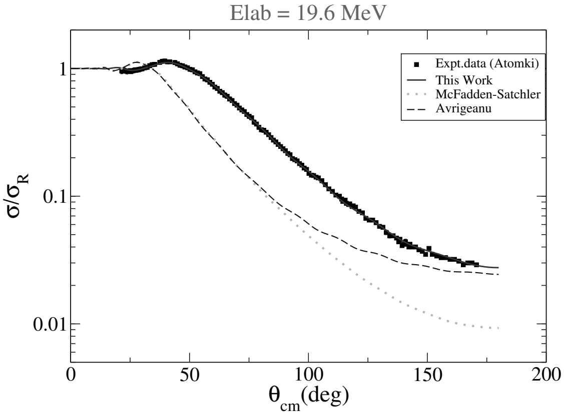

FIG. 1: α + ^{106}Cd Elastic scattering data

also performed using well known global potentials McFadden-Satchler [6] and Avrigeanu [7] which are shown by dotted and dashed lines.

It was observed that two global potentials were unable to describe the elastic scattering data. SFRESCO calculations reproduced the measured elastic scattering data of ^{106}Cd. The local optical potential parameters with χ^2 value for best fit data at 19.6 MeV are listed below

Real part
$V_0 = 68.94$, $R_v = 1.10$, $a_v = 0.57$
Imaginary part
$W_v = 10.81$, $R_v = 1.17$, $a_v = 0.45$

$$\chi^2 \sim 1.098$$

It was seen that χ^2 values are nearly one at lower energies, but worsen at higher energies (from 22 to 27 MeV). The addition of surface imaginary potentials improved the high energy χ^2 by about 10%.

References

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