Microscopic Nucleon Optical Model Potential in Brueckner theory At 65 MeV

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Introduction

Microscopic optical potentials for nucleon-nucleus scattering obtained from the folding of the g-matrices with nucleon density distributions calculated in the relativistic mean field (RMF) framework [1] of the target, have been used to analyze proton and neutron-nucleus scattering over a wide mass range of targets: ^{12}C - ^{208}Pb at 65 MeV. The soft-core Argonne AV-14 [2], AV-18 [3] and the hard-core Hamada-Johnston (HJ) [4] inter-nucleon potentials have been used to calculate the nucleon optical potentials in Brueckner-Hartree-Fock (BHF) theory. The Argonne AV-14 has been used for the first time to calculate nucleon optical potential in BHF and analyze the nucleon scattering data. BHF approach has been widely used to analyze the existing extensive and fairly accurate proton scattering data in the low and intermediate energy regions. However there are relatively very few existing neutron scattering data, especially in the intermediate energy region. The method of calculation is described in Ref. [5]. We solve the Bethe-Goldstone integral equation to calculate the self-consistent nuclear matter optical potential. Self consistency is achieved in 4-5 cycles. The radial dependence of the two nucleon reaction matrices (g-matrices) in all spin iso-spin states (ST: 00, 01, 10, 11) are obtained as described in Ref. [5]. These g-matrices are then folded over the RMF nucleon density distributions to obtain the central and spin-orbit parts of the potentials for the scattering of both neutrons and protons from all the targets considered here. The main motivation for the present work is to finally develop a parameter free nuclear optical potential for the scattering of both protons and neutrons in the low and intermediate energy regions. This would help us in the prediction of reaction and total cross-sections from various targets useful for many applications.

The spherical optical model code is employed to calculate the differential elastic scattering, analyzing power, spin rotation function and integral observables (total, elastic and reaction cross-sections) using the calculated potential (U(E, r)). Comparison with experimental data is done by minimizing χ^2 /DF by generally adjusting four normalization parameters: λ_V, λ_W, λ^R_{SO} and $\lambda^I_{SO.}$. For the data Considered in this work at 65 MeV, we have only two scaling parameters, λ_V, λ_W to obtain χ^2/DF minimum. Hence we have used the microscopic spin-orbit potential without any adjustment.

Results and Discussion

The results of present analysis using the microscopic potentials Argonne AV-14, AV-18 and HJ for the 65 MeV neutron and proton scattering are presented in Figs. 1–3. The differential cross-section and analyzing power for the scattering of 65 MeV nucleon from ^{40}Ca and ^{208}Pb are presented in Fig. 1 and Fig. 2 respectively. Fig. 3 shows our predictions for the spin rotation parameter Q for the scattering of protons from ^{40}Ca and ^{208}Pb. We see that the agreement of AV-14, AV-18 and HJ models with experimental data are satisfactory. Although we do not show figures for other targets (^{12}C, ^{28}Si, ^{56}Fe, ^{90}Zr and ^{120}Sn) considered by us, the agreement with the experimental data is of similar quality.

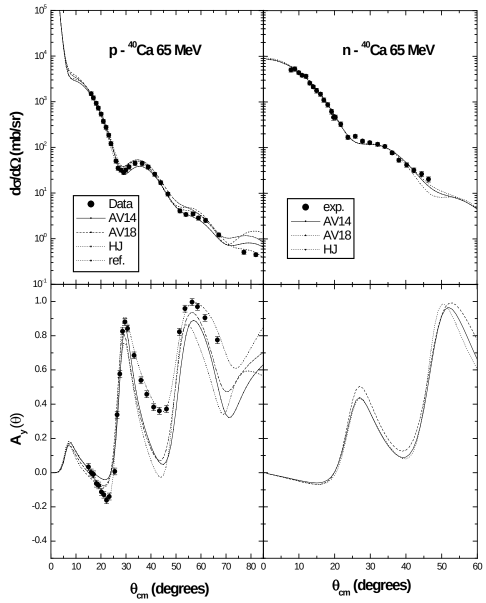

Fig. 1. Differential cross-section and analyzing power for the scattering of 65 MeV (a) protons and (b) neutrons from ^{40}Ca.

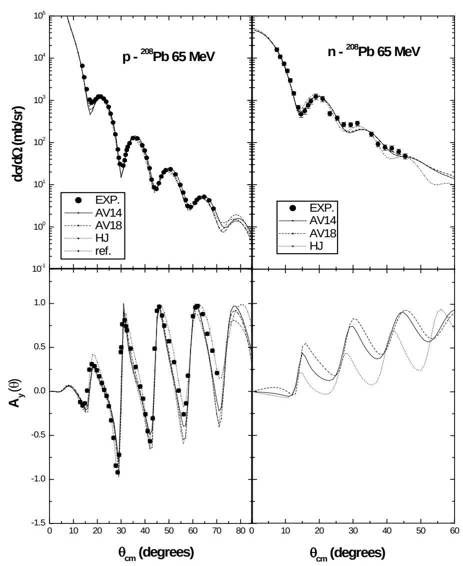

Fig. 2. same as for Fig. 1, but for ^{208}Pb.

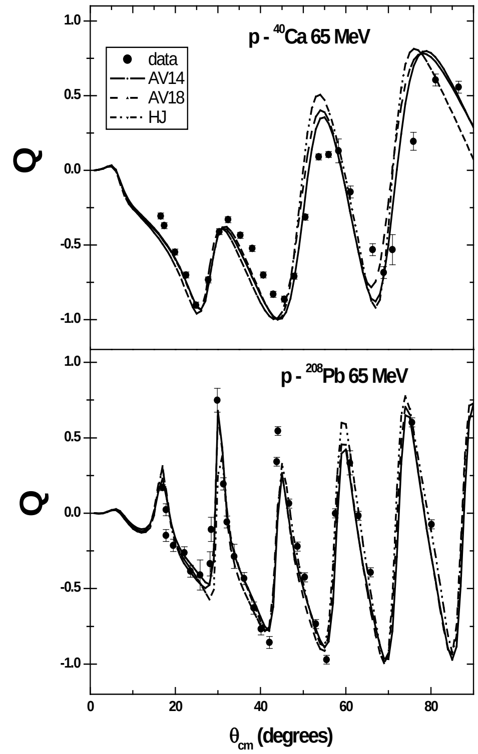

Fig. 3. Predictions of spin-rotation function for proton scattering at 65 MeV.

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