Evidence of decreasing Spin-Orbit potential in Ni-isotopes from an analysis of proton scattering in BHF

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Introduction

Elastic proton scattering at intermediate energies has been successfully employed to study the neutron distribution in nuclei. After the success of Dirac phenomenology [1-2] to explain the polarization observables, we are at a stage to understand the scattering microscopically with the relativistic formalism. At intermediate energies the relativistic impulse approximation RIA has been used to obtain the neutron distribution in a model independent manner. Sakaguchi *et al.* [3] carried out scattering of polarized protons from various nuclei using optical potential fitting using the search code MAGALI of Ranyal.

Keeping this in view we performed a microscopic analysis of 65-MeV-proton scattering data from Ni isotopes within the framework of the Brueckner-Hartree-Fock theory. The effective interaction (g matrix) has been calculated using three Hamiltonians with Argonne v-18[4], Ried93 and NijmII [5] internucleon potentials. The microscopic optical potential is calculated by folding the effective interactions over nucleon density distributions obtained in the relativistic mean field framework[6]. NijmII interactions have been used for the first time to calculate the nucleon-nucleus optical potential. The calculations reproduce the experiment well thus revalidating the use of microscopic optical potential in such analyses.

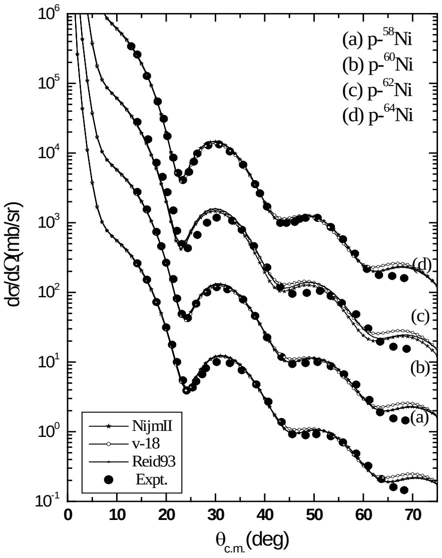
Following the usual practice, the calculated central [real $V(E, r)$ and imaginary $W(E, r)$] and spin-orbit parts [real $V_{so}(E,r)$ and imaginary $W_{so}(E, r)$] of the optical potential are multiplied by normalization constants (λ's), which are adjusted to minimize χ^2 per degree of freedom to reproduce the scattering data. Thus the optical potential used to calculate the desired observables is

$$U(E, r) = \lambda_R V(E, r) + i\lambda_I W(E, r) + \lambda_{soR} V_{so}(E, r) + i\lambda_{soI} W_{so}(E, r). \quad (1)$$

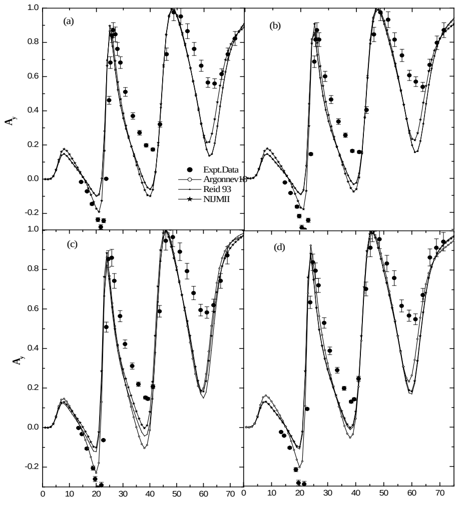
Results and Discussion

The results for the differential cross sections, analyzing power for the scattering of protons from ^{58,60,62,64}Ni are presented in Fig. 1. The figure clearly reveals satisfactory agreement with the scattering data for all the nuclei revalidating the application of BHF approach. Further, the scaling parameters are less than unity for all three internucleon potentials used.

Spin – orbit interaction plays a central role in the understanding of the nuclear structure. The variation of the volume integral per nucleon, of the real part of spin-orbit potential is shown in Fig.2 for Ni isotopes. It is observed that its magnitude decreases with the addition of neutrons reflecting the reduction of spin-orbit interaction with the addition of neutrons.



(a)



(b)

FIG.1. Calculated (best fit) and the corresponding experimental values of (a) differential cross sections and (b) analyzing power for scattering of protons from Ni isotopes using Reid93, Argonne v-18, and NijmII internucleon potentials in the BHF framework.

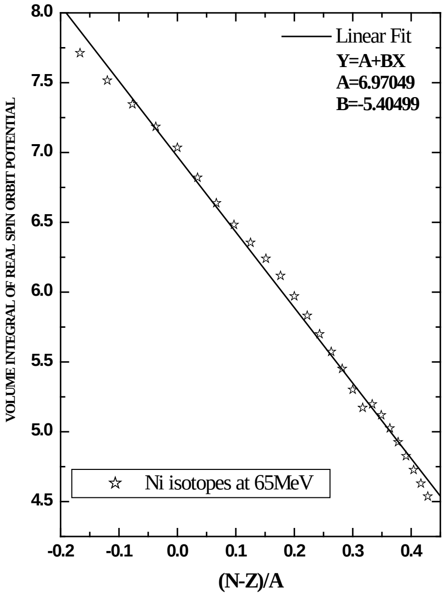


FIG.2. The volume integral per nucleon of the real spin-orbit part of the calculated p-nucleus optical potential with symmetry parameter.

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