Measurements of Spin Rotation Parameters in Proton Elastic Scattering from ^{58}Ni and ^{120}Sn at Intermediate Energies

H. Takeda, H. Sakaguchi, M. Yosoi, M. Itoh, T. Taki, T. Kawabata, T. Ishikawa, M. Uchida, N. Tsukahara, T. Noro[a], M. Yoshimura[a], H. Fujimura[a], H. Yoshida[a], E. Obayashi[a], A. Tamii[b] and H. Akimune[c]

Department of Physics, Kyoto University, Kyoto 606-8502, Japan
[a] *Research Center for Nuclear Physics (RCNP), Osaka University*
[b] *Department of Physics, University of Tokyo*
[c] *Advanced Science Research Center, Japan Atomic Energy Research Institute*

It has been shown that the relativistic impulse approximation (RIA) including density dependent coupling constants and masses of exchanged σ and ω mesons as medium effects has been able to explain cross sections and polarization observables of proton elastic scattering at intermediate energies[1]. Fixing the density dependencies of medium effects with the ^{58}Ni data and using point proton densities deduced from charge densities, neutron density distributions in ^{120}Sn nuclei can be extracted from $p-^{120}$Sn elastic scattering data. Newly measured spin rotation parameters for ^{58}Ni at E_p = 200 MeV and 400 MeV and for ^{120}Sn at E_p = 300 MeV are reviewed in this report. Preliminary search results of neutron density distributions in ^{120}Sn are also reported.

Experimental results and some RIA model calculations of spin rotation parameters for ^{58}Ni at 200 MeV and 400 MeV are displayed in Fig. 1 (a) and Fig. 1 (b), respectively. Solid circles are our data. Only statistical errors are included. Dashed lines are the original RIA calculations[2] without medium modifications except for Pauli blocking, while solid lines indicate RIA calculations with medium modifications, whose parameters were fixed using previouosly measured cross section and analyzing power data. Dotted lines represent RIA IA2 calculations by Tjon and Wallace[3].

Figure 2 shows cross sections, analyzing powers and spin rotation parameters for ^{120}Sn at 300 MeV. Dotted lines are calculations of original RIA and dashed lines are RIA calculations with trial neutron density distributions in target ^{120}Sn nuclei using the best fit medium modification parameters for ^{58}Ni. We searched the neutron densities to reproduce the ^{120}Sn data. Solid lines in Fig. 2 are RIA calculations with the best fit neutron density distributions. Deduced neutron distributions are displayed in Fig. 3. Hatched area in this figure indicates superposition of possible densities, which provide smaller χ^2 than $\chi^2_{\rm min}$ + number of search degrees of freedom. Deduced neutron distribution has an increase at the nuclear center. This result is consistent with the wave function of $3s_{1/2}$ orbit which is expected for ^{120}Sn in a simple shell model.

References

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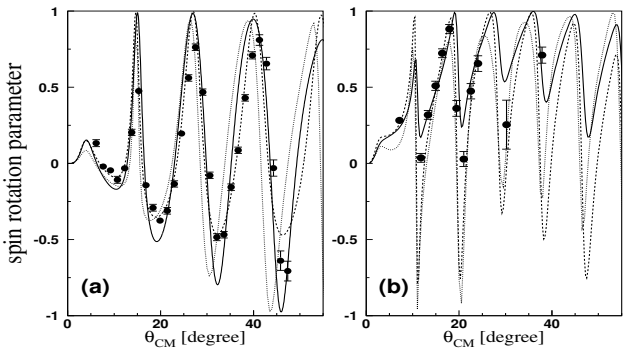

Figure 1: Spin rotation parameters of proton elastic scattering from ^{58}Ni at (a) 200 MeV and (b) 400 MeV. Dashed lines and dotted lines are original RIA calculations of Horowitz and Wallace models, respectively. Solid lines represent the RIA calculations with medium modifications.

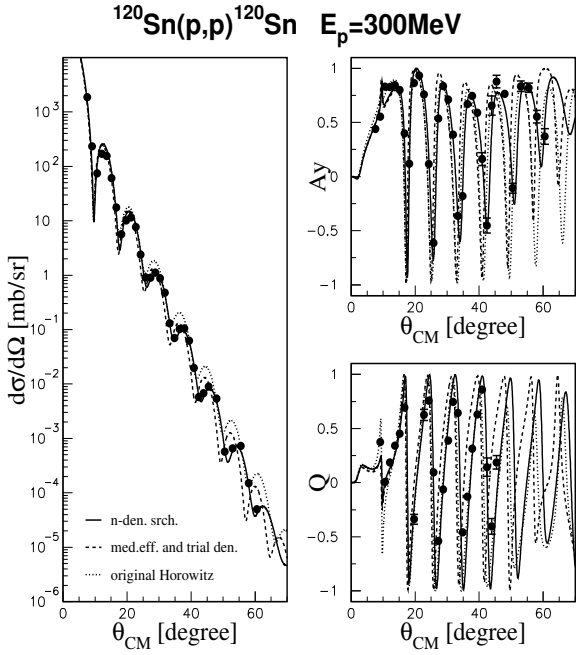

Figure 2: Cross sections, analyzing powers and spin rotation parameters of proton elastic scattering from ^{120}Sn are displayed. Dotted lines are original RIA of Horowitz and dashed lines are RIA calculations with medium effects using trial neutron density distributions of ^{120}Sn. Solid lines indicate calculations using best fit neutron densities.

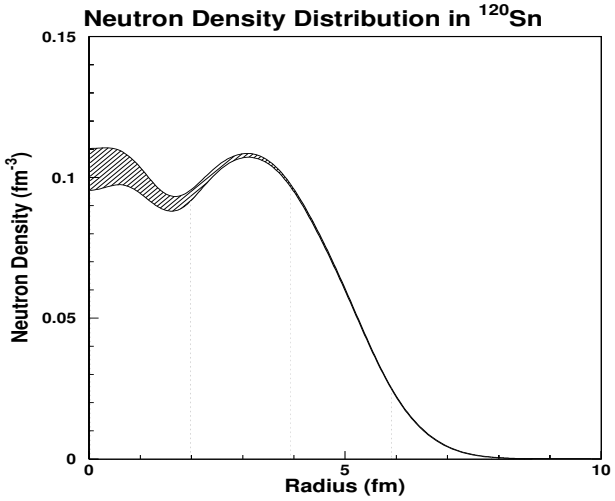

Figure 3: Deduced neutron density distributions in ^{120}Sn. Hatched area represents superposition of possible densities with good χ^2 smaller than $\chi^2_{\rm min}$ plus degrees of freedom.