Extraction of Neutron Density Distributions from Proton Elastic Scattering at Intermediate Energies

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Research fields in nuclear physics are remarkably spreading toward the proton/neutron drip lines due to the recent developments of radioactive isotope beam facilities all over the world. Nuclei far from β stability line are different from stable nuclei not only quantitatively but also qualitatively. For instance neutron rich unstable nuclei are expected to have anomalous structures such as neutron skin and halo. Neutron distributions in nuclei provide fundamental information for nuclear structure study. Thus it is essential to establish procedures to extract neutron density distributions from experimental information.

Protons at intermediate energies are considered to be suitable probe to extract internal information of nuclei because of the large mean free path in nuclear medium. Ambiguities due to the target nuclear structure are relatively small in elastic scattering. Thus we have measured cross sections, analyzing powers and spin rotation parameters of proton elastic scattering at E_p = 200 - 400 MeV using the ring cyclotron at Research Center for Nuclear Physics. We have pointed out[1] that the relativistic impulse approximation (RIA) with density dependent coupling constants and masses of exchanged σ and ω mesons as medium effects has been able to explain the experimental data of 58Ni. In that analysis the same shape of neutron distributions as protons deduced from charge distributions have been assumed for Z = N nuclei because of the charge independence property of nuclear forces.

Assuming the same modification of NN interactions as 58Ni, we applied this medium modi.ed RIA model to Z ≠ N nuclei to extract neutron distributions. Figure 1 indicates the neutron distribution extracted from proton elastic scattering o. ^{120}Sn at E_p = 300 MeV. There is an increase at the nuclear center, which is consistent with the neutron wave function in the 3s½ orbit as expected to be occupied in ^{120}Sn nuclei. Root mean square radius difference between the deduced neutron and proton distributions is found to be consistent with the result derived from a sum rule of spin dipole resonance data[2]. Figure 2 shows cross sections and analyzing powers at all energies we have measured. Solid circles are our experimental data and solid curves are the medium modified RIA calculations with the deduced neutron density. All data are well explained simultaneously by the deduced distribution.

Preliminary results of other tin isotopes ($^{116-124}$Sn) will be also reported on the symposium.

References
[1] H. Sakaguchi et al., Phys. Rev. C57(1998) 1749, and references therein.
[2] A. Krasznahorkay et al., Phys. Rev. Lett. 82 (1999) 3216.

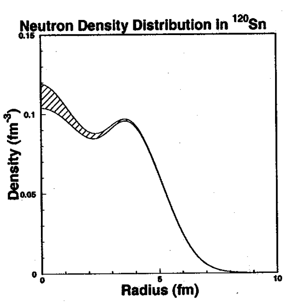

Figure 1: Deduced neutron distribution in ^{120}Sn.

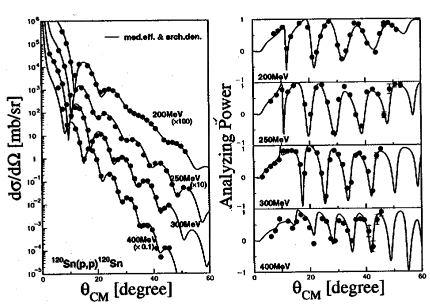

Figure 2: Cross sections and analyzing powers of ^{120}Sn. Solid circles are our experimental data and solid curves are medium modified RIA calculations using the deduced neutron distribution.