Neutron density distributions of the Sn isotopes and Ca isotopebs extracted from the proton elastic scattering

S. Terashima[1], H. Sakaguchi[1], H. Takeda[2], T. Murakami[1],M. Uchida[3],T. Ishikawa[4],M. Itoh[3], T. Kawabata[5],Y. Yasuda[1],J. Zenihiro[1],M. Yosoi[1], T. Suda[2],T. Ohnishi[2],H. P. Yoshida[3], T. Noro[6],S. Asaji[6],K. Ishida[6] ,K. Yonemura[6]

[1] Department of Physics, Kyoto University, Kyoto 606-8502, Japan
[2] Institute for Chemical and Physical Research (RIKEN), Wako, Saitama 351-0106, Japan
[3] Research Center for Nuclear Physics (RCNP), Ibaraki, Osaka 567-0047, Japan
[4] Laboratory of Nuclear Science, Tohoku University, Sendai, Miyagi 982-0216, Japan
[5] Center for Nuclear Study, University of Tokyo, Wako, Saitama 351-0198, Japan
[6] Department of Physics, Kyushu University, Japan

Contact e-mail: tera@nh.scphys.kyoto-u.ac.jp

Cross sections and analyzing powers of proton elastic scattering off ^{58}Ni, ^{40,42,44,48}Ca, and ^{116,118,120,122,124}Sn have been measured up to the angle of 3.5 fm^{-1} in momentum transfer to deduce a systematic change of neutron density distributions. The mean free path of intermediate energy protons in nuclear matter is large enough to penetrate into the nucleus, providing some sensitivity to the nuclear interior. The measurement has been performed at RCNP Osaka University ring cyclotron with the use of the Grand Raiden spectrometer, the focal plane counters.

We used the relativistic impulse approximation (RIA) calculation [1]. Since the shapes of neutron and proton density distributions are supposed to be the same in ^{58}Ni, we have used the proton elastic scattering from ^{58}Ni as a reference to tune the relativistic Love-Franey interaction that the coupling constants and masses of exchanging mesons are depend on nuclear density distributuins [2]. Point proton distributions are unfolded from the existing charge distribution data [3, 4]. After confirming that our interaction is applicable to the scattering off heavier nuclei such as the proton elastic scattering off ^{208}Pb at nearby beam energy [5] by using the same parameters of ^{58}Ni [6], we applied the elastic scattering to deduce the neutron density distributions of Ca and Sn isotopes by using the proton density distributions and the tuned interaction. The result of our analysis shows a clear systematic behavier which shows a gradual filling in the $1f_{7/2}$ and $3s_{1/2}$ neuton single particle orbit and a systematic change of neutron thickness.

We have been planning the proton elastic scattering off unstable nuclei experiment at the intermidiate energy by using inverse kinematics. We measure the proton elastic scattering the scattering angles and the energies of the recoiled protons from hydrogen target. We expect to be able to extract the neutron density distributions of not only stable nuclei but unstable nuclei.

1. C.J. Horowitz et al., *Computional Nuclear Physcs 1*, (Springer-Verlag, Berlin, 1991)
2. H. Sakaguchi, et al., Phys. Rev. **C57**, (1998) 1749
3. H. de Vries et al., Atomic Data and Nuclear Data Tables **36**(1987) 495
4. G.G. Simon et al., Nucl. Phys. A **A 333**, (1980) 381.
5. D.A Hutheon et al., Nucl. Phys.**A483**, (1988) 429
6. H. Takeda,Doctor Thesis(2002). Kyoto University,to be submitted to Phys. Rev. C.