Neutron density distributions in ^{40,42,44,48}Ca observed via polarized proton elastic scattering at 300MeV

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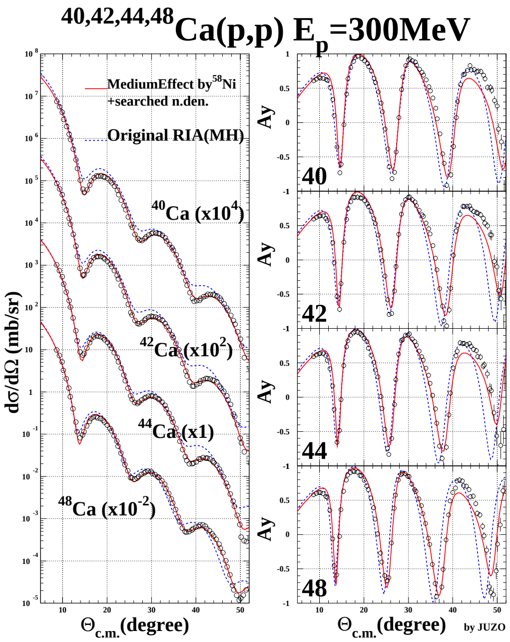
It is only Ca isotopes in stable nuclei which can let us investigate the systematic behavior of neutron distributions from one magic number to the next. From a lot of electron scattering data, charge radius of Ca isotopes has a minimum at ^{48}Ca and does not increase proportional to $A^{1/3}$ [1]. It is of great interest whether the neutron radius increases or not according to the neutron number. In addition, as the "medium effect" has been already successful in heavier nuclei than ^{58}Ni[2], Ca isotopes are good probes to know whether it can be also applied to lighter ones or not. The medium effect means the coupling constants and masses of the exchanged meson such as σ and ω mesons, change according to the density in the nuclear medium.

The experiment has been performed at the Ring Cyclotron of RCNP using the Grand Raiden spectrometer and introducing the target changing system to reduce the systematic ambiguity between targets due to the drift of the beam condition. Thus we have been able to measure each angular distributions of cross sections and analyzing powers of 300MeV polarized proton elastic scattering from ^{40,42,44,48}Ca simultaneously.



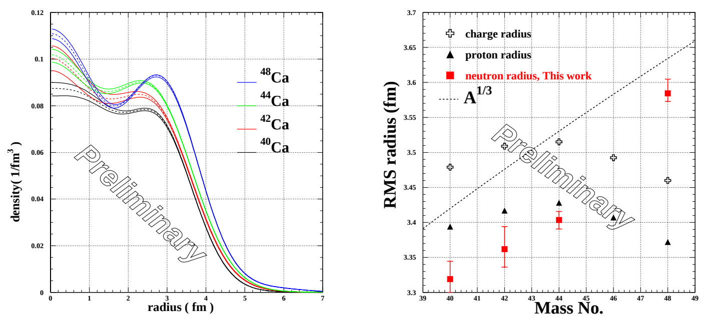


Figure 1: In the left the exp. datas and RIA calc. of the cross sections and analyzing powers are shown. The red is the medium modified RIA calc.. The blue is the original one by Horowitz *et al.* The two figures above show neutron density distributions with their error bands deduced from exp. data and root-mean-square (RMS) radii. The squares are RMS radii of neutron dens., the triangles are those of proton dens., the crosses are charge radii.

In order to explain the experimental data, we have used the medium modified relativistic impulse approximation (RIA) by introducing the "medium effect" to original RIA by Horowitz *et al* [3]. We have also used realistic point proton distributions by unfolding model independent charge distributions[1]. In this work we have taken into account the effect of intrinsic charge distribution inside neutron as well as that of proton[4], which makes the proton distributions more gradual and the RMS radius larger than the case only proton charge assumed.

By using realistic proton distributions, we have succeeded in extracting neutron distributions from the proton elastic scattering. The left figure shows the experimental data and medium modified RIA calculations of the cross sections and analyzing powers at each Ca isotope. In the right figures the isotope shift of neutron density distributions due to the occupation of the $1f_{7/2}$ neutron orbit is seen around 3 fm and ^{48}Ca has a large neutron skin of ~ 0.2 fm compared with the other three Ca isotopes.

References

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