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Manifestation of Three-nucleon Spin-orbit Interaction in Nuclear Charge Radii

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The nuclear charge radii have supplied high-precision and model-independent data on nuclear structure. In particular, thanks to the collaboration of atomic physics, difference of the charge radii among isotopes, i.e. isotope shifts (field shifts, to be more precise), have been measured with striking precision. The isotope shifts have been known to be a good indicator for variation of nuclear structure along an isotopic chain. They may also provide information of the nucleonic interaction. The isotope shifts in the Pb nuclei was suggested to be relevant to the isospin content of the nucleonic LS interaction two decades ago. However, fictitious degeneracy or level inversion had to be introduced to reproduce the observed kink in the isotope shifts of the Pb nuclei.

Via a self-consistent mean-field (SCMF) study, I point out that the three-nucleon (3N) interaction, which has been indicated by the chiral effective field theory (EFT) and pointed out to narrow the gap between the theoretical description and experiments of the ls splitting, may also solve the problem of the isotope shifts. The kink in Pb is described fairly well with a reasonable single-particle-level difference between the relevant orbitals. It is found that the close charge radii between 40Ca and 48Ca, which is another long-standing problem, are well reproduced as well. As the SCMF calculations clarify physics mechanism how the 3N LS interaction influences the nuclear charge radii, these data can be regarded as a manifestation for the 3N LS interaction. It is suggested that kinks as observed in Pb can be universal at the neutron magicity in the isotopes with magic proton numbers. As an example, a kink is predicted in the isotope shifts of Sn at N=82, which will be a touchstone of this picture linking the nuclear radii and the 3N LS interaction.

Primary author: Prof. NAKADA, Hitoshi (Chiba University)

Presenter: Prof. NAKADA, Hitoshi (Chiba University)