【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Mathematical and physical sciences)

Title of Project : Electron Scattering for Measurements of Charge Density Distribution of Short-Lived Nuclei

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Research Area : Nuclear physics (experiment)

Keyword : elastic electron scattering, short-lived nuclei, charge form factor, SCRIT, ion trap

【Purpose and Background of the Research】

The purpose of this research is to determine the charge density distribution, i.e. size and shape, of rarely-produced short-lived nuclei by electron scattering.

It is recognized today that short-lived nuclei play essential roles for nucleosynthesis in the universe. To understand its scenario, understanding of the internal structure of those short-lived nuclei is important. This is because nucleosysnthesis is a nuclear-reaction chain, and reaction probability depends strongly on their internal structure.

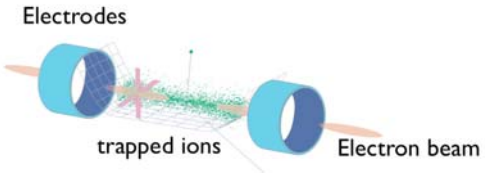
For structure studies of atomic nuclei, electron scattering is the best probe. Indeed, our understanding of nuclear structure of stable nuclei was finally established by results of a series of electron scattering experiments carried out about a half-century ago by R. Hofstadter (1961, Nobel prize in physics).

For short-lived nuclei, however, no one ever succeeded to perform this study due to difficulties of their production and treatment because of short lifetime.

We established an innovative technique to overcome these difficulties, and demonstrated its feasibility for the first time in the world. It is now time to apply to short-lived nuclei to investigate their internal structure.

【Research Methods】

This research will be carried out using a high energy electron storage ring recently installed at RI Beam Factory, Nishina Center, RIKEN, JAPAN. In such an electron storage ring, "ion trapping" is a notorious phenomena that people make much efforts to remove it. It is a phenomenon that ionized residual gas ions by electron beam are trapped by electron beam itself. Since they stay on electron beam, electron scattering take place, which reduces the number of electrons in the ring. This reduces ring performance, thus it is serious problem for such rings used for synchrotron radiation. Our idea is to trap short-lived nuclei externally injected by using this ion trapping. Once they are trapped, electron scattering off them automatically takes place.



A set of electrodes is placed on electron beam to trap also longitudinal direction (electron beam direction) as shown in the figure above. By manipulating applied voltage to the electrode, one is easy to inject, trap and extract short-lived nucleus ions trapped on electron beam. In this way, one can target short-lived nuclei for electron scattering, for the first time, by keeping purity of the target.

In this research project, a high resolution magnetic spectrometer is constructed for detecting elastically scattered electrons. The first target will be 132Sn isotope whose life time is only 40 seconds. It is a doubly-magic nucleus, namely the number of protons and neutrons are both magic number.

【Expected Research Achievements and Scientific Significance】

This research project will realize the structure studies of short-lived nuclei by electron scattering for the first time, which has been long time considered to be impossible, and provide essential information on the internal structure of short-lived nuclei.

【Publications Relevant to the Project】

1. "First Demonstration of Electron Scattering Using a Novel Target Developed for Short-Lived Nuclei". T. Suda *et al.*, Phys. Rev. Lett. 102(2009) 102501.
2. "Novel Internal Target for Electron Scattering off Unstable Nuclei". M. Wakasugi *et al.*, Phys. Rev. Lett. 100(2008) 164801.

【Term of Project】 FY2010-2014

【Budget Allocation】 156,200 Thousand Yen

【 Homepage Address and Other Contact Information】

http://www.lns.tohoku.ac.jp/~scrit