【 Study of Internal Structure of Unstable Nuclei by Electron Scattering 】

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My study Purpose

Elucidation of the internal structure of unstable nuclei by electron scattering

One of a important tool for internal structure of nuclear physics

Usual electron elastic scattering

Target： stable nuclei (～10^{20} [/cm^2])
Luminosity：10^{27}～ [/cm^2/s]

Electron scattering off short-lived unstable nuclei

Production hard
Decay due to its finite lifetime
⇒ Difficulty for preparing target

SCRIT (Self-Confining Radioactive-isotope Ion Target) facility

The world's first facility for electron scattering off unstable nuclei

Electron elastic scattering experiments with small number of targets are possible!

SCRIT method

@ RIKEN RI Beam factory

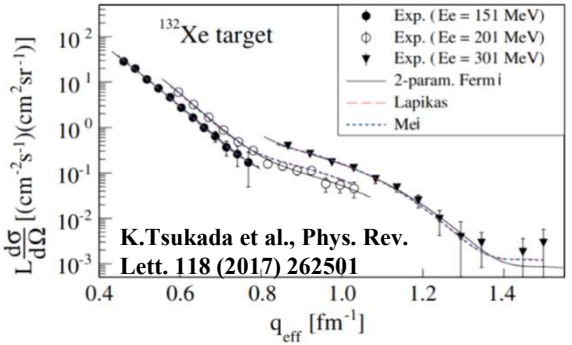
My research goal

The Electron scattering experiment with unstable nuclei using the SCRIT method

< The measurement of the charge density distribution in wide momentum transfer >

Cross section $\left(\frac{d\sigma}{d\Omega}\right) = \left(\frac{d\sigma}{d\Omega}\right)_{Mott} |F(q)|^2$

Form factor $F(q) = \int e^{-i\boldsymbol{q}\cdot\boldsymbol{r}} \rho(\boldsymbol{r}) d\boldsymbol{r}$



< The measurement of the 4th-order moment of the charge density distribution in low-q>

The nth-order moment of charge density distribution

- Higher-order components can amplify the contribution of neutrons.

H. Kurasawa and T. Suzuki, PTEP 10.1093/ptep/ptz121
H. Kurasawa, T. Suda, T. Suzuki, arxiv.org:2009.00759v1

$$\langle r^4 \rangle_c = \langle r^4 \rangle_p + \frac{10}{3}\langle r^2 \rangle_{p(point)} \langle r_p^2 \rangle + \frac{10}{3}\frac{N}{Z}\langle r^2 \rangle_{n(point)} \langle r_n^2 \rangle + (relativistic\ corr.)$$

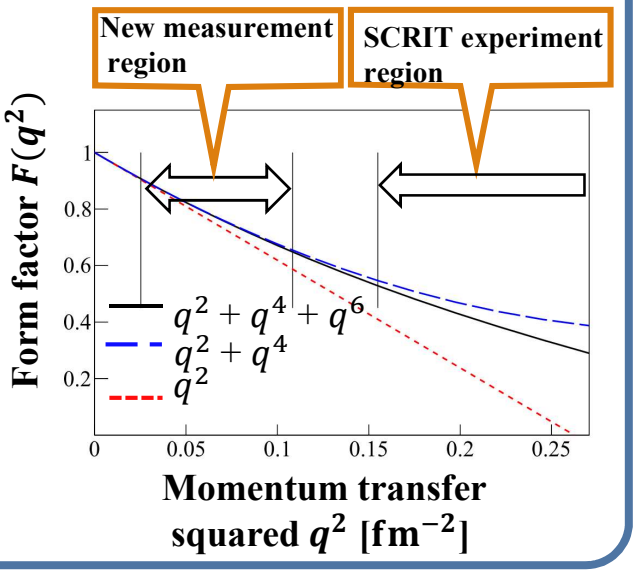
Point proton radius

Proton radius

Neutron radius

Point neutron radius

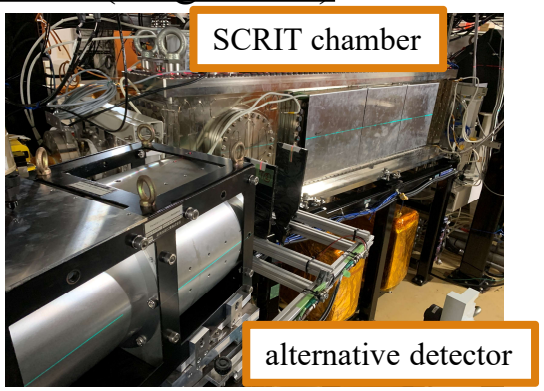
Form factor in low-q $F(q) = 1 - \frac{\langle r^2 \rangle_c}{6} q^2 + \frac{\langle r^4 \rangle_c}{120} q^4 - \frac{\langle r^6 \rangle_c}{5040} q^6 \ldots$



< Plan of Research >

2020

- **Development of the detector for the measurement of 4^{th} moment of the charge density distribution**
  - ✓ Background measurement with the alternative detector (Aug. 2020)
  - ☐ Creation of new detector (~until 2021)



- **Simulation**
  - Targets : Xe isotope
    (stable : $^{126-136}$Xe, unstable : ^{13} ,^{140}Xe)
  - Detector : CsI calorimeter

2021

- **The experiment with Xe stable isotope targets using new detector**
  - Comparison of traditional SCRIT setup and new one
    - Establishment of neutron distribution radius measurement method
    - Isotope dependence of the charge density distribution and neutron distribution radius

2022

- **The experiment using Xe unstable isotope targets**
  - The world's first electron scattering experiment with unstable nuclear targets.
  - Determination of the neutron distribution radius of unstable nuclear targets.

< Plan of overseas training in 2020>

- ~~International Summer Student Program at GSI-FAIR, Aug. – Sep., 2020 (one and a half months)~~

  ⇒ **Canceled by COVID-19**

- **Discussion with theorists (1 month in this year)**
  - Xe used in the experiment is a deformed nucleus
  - Theoretical interpretation of the obtained experimental data
    - Learning deformed nuclei
    - Understanding the accuracy of neutron distribution radius measurement

< Plan of GPPU credit>

Required points GSPs : 10P, GEPs : 13P

2020 GPPU seminar : 2 GSPs (~Mar., 2021)
GPPU school : 3 GSPs (Dec., 2020)
GPPU Experimental course : ~~12 GEPs~~ ⇒ 8 GEPs (Oct. ~ Dec., 2020)
※poor physical condition

2021 5 GSPs, 5 GEPs, Overseas training : 2 months

2022 (spare year)