

**E403**

## PROPOSAL FOR EXPERIMENT AT RCNP

July 18, 2012

**TITLE:****Study of Gamow-Teller transitions in  $\beta^+$  direction by ( ${}^7\text{Li}, {}^7\text{Be}$ ) reactions at 70 MeV/nucleon****SPOKESPERSONS:**

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**RUNNING TIME:**

$^{12}\text{C}$ , $^{24}\text{Mg}$ , $^{27}\text{Al}$ , $^{28}\text{Si}$ , $^{58}\text{Ni}$ , target nuclei:	3.5 days
Beam preparation, dispersion matching, sieve slit runs:	1.5 days
Total:	5 days

**BEAM LINE:**

Ring : WS course, high resolution mode

**BEAM REQUIREMENTS:**

Type of particle	$^7\text{Li}$
Beam energy	70 MeV/nucleon
Beam intensity (max.)	30 enA
Energy resolution	$\Delta E \leq 150$ keV, small emittance

**BUDGET:**

Enriched targets and material:  $^{24}\text{Mg}$ ,  $^{58}\text{Ni}$ : 200k yen

**SCHEDULE:**

We request the beam time in November/December, 2013 or January/February, 2014

# 1 Summary of Experiment

- **Summary of proposal and experiment:**

Studies of Gamow-Teller (GT) transitions in the  $\beta^+$  direction (GT<sup>+</sup> transitions) give important information for the study of nuclear structure. In addition, GT<sup>+</sup> transitions play important roles in astrophysical processes, such as electron-capture process, at the core-collapse stage of supernovae.

The  $(n, p)$ -type charge-exchange (CE) reactions such as  $(n, p)$ ,  $(d, ^2\text{He})$  or  $(t, ^3\text{He})$  reactions have been used to study GT<sup>+</sup> responses of nuclei up to high excitation energies. However, each of them has its own disadvantages and clear and detailed study of GT<sup>+</sup> strengths was not easy.

Here we propose the heavy-ion CE reaction ( $^7\text{Li}, ^7\text{Be}$ ) as a better alternative reaction to be performed at RCNP. Therefore, the main objective of this proposal is to examine the properties of the ( $^7\text{Li}, ^7\text{Be}$ ) reaction at 70 MeV/nucleon and  $0^\circ$  as a means to study GT<sup>+</sup> responses of nuclei.

At RCNP, we have established beam matching techniques for the system consisting of “WS course” and the spectrometer “Grand Raiden” and a resolution of  $\approx 30$  keV has been achieved regularly in the study of GT<sup>-</sup> responses of nuclei using the ( $^3\text{He}, t$ ) CE reaction at 140 MeV/nucleon [1]. We first apply the same beam matching techniques in the study of GT<sup>+</sup> responses using the ( $^7\text{Li}, ^7\text{Be}$ ) reaction at 70 MeV/nucleon and  $0^\circ$ . Then, we examine the properties of the reaction, especially the proportionality between the reaction cross-sections and the GT strengths [ $B(\text{GT})$ ] by studying GT excitations for several targets whose GT<sup>+</sup> response is well studied or well estimated. Nuclei  $^{12}\text{C}$ ,  $^{24}\text{Mg}$ , and  $^{28}\text{Si}$  are even-even nuclei with the same proton and neutron numbers, i.e.,  $T_z = (N - Z)/2 = 0$ . Therefore, the quality of the data from the ( $^7\text{Li}, ^7\text{Be}$ ) reaction can be examined by comparing with the existing high-resolution ( $^3\text{He}, t$ ) data assuming mirror symmetry of GT transitions in the GT<sup>+</sup> and GT<sup>-</sup> directions. The GT strengths in the GT<sup>+</sup> direction starting from  $^{27}\text{Al}$  and  $^{58}\text{Ni}$  are estimated by using the results of the isospin decomposition presented in Refs. [1, 2].

- **Apparatus and beam properties:**

The spectrometer Grand Raiden and the standard VDC focal plane detector system will be used for the analysis and detection of outgoing  $^7\text{Be}$ . We request at least  $\approx 10$  enA of good quality single-turn extracted 70 MeV/nucleon  $^7\text{Li}$  beam. In order to realize various matching conditions, full capabilities of the WS course will be utilized.

- **Beam time request:**

Measurement for  $^{12}\text{C}$ ,  $^{24}\text{Mg}$ ,  $^{27}\text{Al}$ ,  $^{28}\text{Si}$ ,  $^{58}\text{Ni}$  : 3.5 days

Beam preparation, dispersion matching, sieve slit runs : 1.5 days

- **Schedule:**

We request beam time in November/December, 2013 or January/February, 2014