RCNP EXPERIMENT E307

PROPOSAL FOR EXPERIMENT AT RCNP

12 July, 2007

TITLE:
High-resolution (^{3}He, t) studies of Gamow-Teller transitions from ^{44}Ca, ^{40}Ca and ^{50}Ti nuclei

SPOKESPERSON:

Full Name	Tatsuya Adachi
Institution	Research Center for Nuclear Physics, Osaka University
Title or Position	Researcher
Address	10-1 Mihogaoka, Ibaraki, Osaka, 567-0047, Japan
Phone number	+81-6-6879-8935
FAX number	+81-6-6879-8899
E-mail	adachi@rcnp.osaka-u.ac.jp

EXPERIMENTAL GROUP:

Full Name	Institution	Title or Position
Y. Fujita	Department of Physics, Osaka University	Associate Professor
K. Hatanaka	RCNP, Osaka University	Professor
H. Okamura	RCNP, Osaka University	Professor
F. D. Smit	iThemba LABS, South Africa	Senior Researcher
A. Tamii	RCNP, Osaka University	Associate Professor
H. Fujita	University of the Witwatersrand, South Africa (Also at iThemba LABS, South Africa)	Researcher
R. Neveling	iThemba LABS, South Africa	Researcher
Y. Shimbara	Niigata University	Research Associate
K. Suda	RCNP, Osaka University	Researcher
N.T. Khai	Department of Nuclear Physics, Institute of Physics and Electronics, Vietnam	Researcher
Y. Tameshige	RCNP, Osaka University	D3
C. Scholl	IKP, Universität zu Köln, Germany	PhD student
H. Matsubara	RCNP, Osaka University	D2
T. Ohta	RCNP, Osaka University	D2
M. Kato	RCNP, Osaka University	M2

RUNNING TIME:

Correction of aberration by MS magnet	0.5 days
Data runs (1.0 day for each targets)	3.0 days

(In addition, we usually need 2.0 days for the beam tuning, and 0.5 days for setting up the matching conditions between the beam line and the spectrometer.)

BEAM LINE: Ring : WS course

BEAM REQUIREMENTS:

Type of particle	^{3}He
Beam energy	420 MeV
Beam intensity	30 $\sim$ 40 nA
Energy resolution	Δ E $\leq$ 100 keV (Achromatic

mode)
Any other requirements halo-free, small emittance

BUDGET:

^{40}Ca metallic foil	$\sim$ 0.2 million yen
^{44}Ca metallic foil	$\sim$ 0.3 million yen
(Size of both foils are 2 cm x 3 cm x 2 mg/cm^2)	
Glove Box	$\sim$ 1 million yen

TITLE:
High-resolution (^{3}He, t) studies of Gamow-Teller transitions from ^{44}Ca, ^{40}Ca and ^{50}Ti nuclei

SPOKESPERSON: Tatsuya Adachi

SUMMARY OF THE PROPOSAL

The Gamow-Teller (GT) transition strength, B(GT) value, is studied by high resolution (^{3}He, t) experiment at 140 MeV/nucleon and at 0°. This study is based on an isospin symmetry structure in isobars and a proportionality between a cross section and a B(GT) value measured by β decay experiment. For a long time, the extraction of B(GT) values was limited in the nuclear mass system which there is a "standard" B(GT) values from β decay measurement. In order to overcome this difficulty, a R^2 value defined by the GT and Fermi unit cross section is derived by two ways. One is to derive a R^2 value by combined analysis of $T_z = \pm 1 \rightarrow 0$ mirror transitions measured by (^{3}He, t) and β decay experiments. The other is to derive a R^2 value by systematic studying nuclear mass dependence of R^2 values in the region of $A = 7 - 178$. By deriving R^2 value from either of two, we can extract B(GT) values for the mass system in which there is no "standard" B(GT) value from β decay measurement.

We propose to measure B(GT) distributions by high resolution experiments of ^{44}Ca(^{3}He, t)^{44}Sc, ^{40}Ca(^{3}He, t)^{40}Sc and ^{50}Ti(^{3}He, t)^{50}V. Scientific motivations are following.

(1) ^{44}Ca(^{3}He, t)^{44}Sc and ^{40}Ca(^{3}He, t)^{40}Sc experiments

Since calcium isotopes are $Z = 20$ shell closure nuclei, the precise B(GT) distributions extracted by high resolution (^{3}He, t) experiments are the best examples to discuss spin-isospin interaction in pf-shell region. As an extension of the studies of B(GT) distributions starting from ^{42}Ca and ^{48}Ca isotopes, we propose ^{44}Ca(^{3}He, t)^{44}Sc and ^{40}Ca(^{3}He, t)^{40}Sc experiments. In addition, to observe the GT distribution on the ^{40}Ca(^{3}He, t)^{40}Sc experiment is interesting to study ground state correlation.

(2) ^{50}Ti(^{3}He, t)^{50}V experiment

By analyzing the data between ^{50}Cr(^{3}He, t)^{50}Mn and ^{50}Fe β decay, we confirmed that the combine analysis of $T_z = \pm 1 \rightarrow 0$ mirror transitions can be used for the R^2 derivation and the B(GT) extraction. Further, by analyzing data between ^{52}Cr(^{3}He, t)^{52}Mn and ^{52}Ni β decay, we confirmed that the combine analysis of $T_z = \pm 2 \rightarrow +1$ and $T_z = \pm - 2 \rightarrow -1$ mirror transitions can be used. As an extension of these studies, we propose to perform ^{50}Ti(^{3}He, t)^{50}V experiment. By combining with total half life measured by the β decay experiment of ^{50}Ni, we can study whether the combined analysis of $T_z = +3 \rightarrow +2$ and $T_z = -3 \rightarrow -2$ mirror transitions is used.

For an instrumental development, we propose to install more powerful supply. As we have a higher resolution, we started to suffer from the second order aberrations of Grand Raiden. This large aberration can be reduced by increasing the current of the sextupole part of the multipole magnet (MS).