RCNP EXPERIMENT E315

PROPOSAL FOR EXPERIMENT AT RCNP

14 February 2008

TITLE:
Investigation of M1 States and Assignment of Isospin for Fe and Ni Isotopes by Combining (p,p') and $(^3\mathrm{He},t)$ Reactions

SPOKESPERSON:

Full Name	Yoshihiro Shimbara
Institution	Graduate School of Science and Technology, Niigata University
Title or Position	Assistant Professor
Address	8050 Ikarashi 2-nocho, Nishi-ku, Niigata, Japan, 950-2181
Phone number	+81-25-262-6269
FAX number	+81-25-262-6142
E-mail	shimbara@np.gs.niigata-u.ac.jp

Full Name	Yoshitaka Fujita
Institution	Department of Physics, Osaka University
Title or Position	Associate Professor
Address	1-1 Machikaneyama, Toyonaka, Osaka, Japan, 560-0043
Phone number	+81-6-6850-5506
FAX number	+81-6-6850-5516
E-mail	fujita@rcnp.osaka-u.ac.jp

EXPERIMENTAL GROUP:

Full Name	Institution	Title or Position
Atsushi Tamii	RCNP, Osaka Univ.	Assoc. P
Tatsuya Adachi	RCNP, Osaka Univ.	PD
Hirohiko Fujita	Witwatersland Univ.	PD
Kichiji Hatanaka	RCNP, Osaka Univ.	P
Daiki Ishikawa	RCNP, Osaka Univ.	M1
Juzo Zenihiro	Dep. of Physics, Kyoto Univ.	D3
Takahiro Kawabata	CNS, Univ. of Tokyo	Assist. P
Toru Kubo	Grad. School of Science and Technology, Niigata Univ.	M1
Hiroaki Matsubara	RCNP, Osaka Univ.	D2
Takashi Ohtsubo	Grad. School of Science and Technology, Niigata Univ.	Assoc. P
Susumu Ohya	Grad. School of Science and Technology, Niigata Univ.	P
Hiroyuki Okamura	RCNP, Osaka Univ.	P
Harutaka Sakaguchi	Dept. of Applied Physics, Miyazaki Univ.	P
Kenji Suda	RCNP, Osaka Univ.	PD
Yuji Tameshige	RCNP, Osaka Univ.	D3
Ryota Yamada	Grad. School of Science and Technology, Niigata Univ.	M1
Masaru Yosoi	RCNP, Osaka Univ.	Assoc. P
Ryota Watanabe	Grad. School of Science and Technology, Niigata Univ.	M1
Remco Zegers	NSCL, Michigan State Univ.	Assist. P

RUNNING TIME:	Installation time without beam	1 days
	Beam tuning time	2 days
	Data runs	14 days
BEAM LINE:		Ring : WS course
BEAM REQUIREMENTS:	Type of particle	Polarized proton
	Beam energy	160 MeV
	Beam intensity	$2 - 20$ nA
	Energy resolution	$\Delta E \leq 40$ keV, small emittance
BUDGET:	Target ladders and frames	400 kyen
	Enriched isotopes	1,000 kyen
	Improvement of 0-degree beam line	500 kyen
	Travel and local expenses	600 kyen

TITLE:
Investigation of M1 States and Assignment of Isospin for Fe and Ni Isotopes by Combining (p, p') and (^{3}He,t) Reactions

SPOKESPERSON: Yoshihiro Shimbara

SUMMARY OF THE PROPOSAL

Random-matrix theory has been used to describe certain statistical properties of nuclear levels. The spectral fluctuation properties of sequences composed of levels with the same quantum numbers, e.g., spin, isospin, or parity, are typically those of the random matrices of the Gaussian orthogonal ensemble (GOE). Up to now the experimental tests for nuclear system are very limited, because such tests require complete spectrum which have no or few missing states and pure quantum number. Particularly, isospin assignments for levels are very limited compared to spin or parity. For further study of RMT in nuclear system, assignment of isospin quantum number is necessary.

Complete spectra with assignment of quantum number is also attractive for the study of isospin symmetry. Many previous studies suggest that the isospin is approximately a good quantum number in nuclei. However, it is very hard to quantitatively estimate the breaking of the isospin symmetry, because one state can correlate many other neighboring states. In order to study the isospin symmetry breaking, the nearest-neighbor spacing distribution (NNSD) are recently used. If the levels in an energy spectrum have the same isospin (different isospins), in which the correlations between those states are strong (weak), the NNSD shows the GOE (Poisson) distribution. If the isospin is broken, the NNSD composed of the different isospins shifts to the GOE distribution.

The intermediate energy (p, p') and (^{3}He,t) reactions provide almost pure 1^+ spectra at zero degrees. The similarity of the reaction mechanism between (p, p') and (^{3}He,t) reactions results in similar spectra for the same target. The major differences are the isospin selection rule and the transition strengths proportional to the squares of the isospin Clebsh-Goldan coefficients. By comparing the energy spectra of the (p, p') and (^{3}He,t) reactions, one can identify isospin quantum number for the excited states. Previously, we performed the experiments of ^{54}Fe(^{3}He,t)^{54}Co, ^{56}Fe(^{3}He,t)^{56}Co, ^{60}Ni(^{3}He,t)^{60}Cu, and ^{62}Ni(^{3}He,t)^{62}Cu at 0 degrees. Then, many discrete 1^+ states were observed. Here, we propose high-resolution experiments of ^{54}Fe$(p, p')^{54}$Fe, ^{56}Fe$(p, p')^{56}$Fe,

^{60}Ni$(p,p')^{60}$Ni, and ^{62}Ni$(p,p')^{62}$Ni at forward angles including 0 degrees. Almost pure $J^{\pi} = 1^{+}$ spectra for ^{54}Fe, ^{56}Fe, ^{60}Ni and ^{62}Ni will be obtained. By comparing the spectra with the previous (^{3}He,t) spectra, isospin assignments will be performed for the $A = 54$ (^{54}Fe, ^{54}Co), $A = 54$ (^{56}Fe, ^{56}Co), $A = 60$ (^{60}Ni, ^{60}Cu), and $A = 60$ (^{62}Ni and ^{62}Cu) systems.