RCNP EXPERIMENT E282

PROPOSAL FOR EXPERIMENT AT RCNP

26-Jan-2006

TITLE:

High-resolution study of $M1$ and $E1$ excitations in ^{208}Pb

SPOKESPERSONS:

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EXPERIMENTAL GROUP:

Name	Institution	Title or Position
T. Adachi	RCNP, Osaka Univ.	Researcher
J. Carter	Univ. of Witwatersrand, Johannesburg	Professor
M. Dozono	Dep. of Physics, Kyushu Univ.	M1
H. Fujita	Univ. of Witwatersrand and iThembaLABS	Researcher
K. Fujita	RCNP, Osaka Univ.	D3
Y. Fujita	RCNP, Osaka Univ.	Assoc. Professor
K. Hatanaka	RCNP, Osaka Univ.	Professor
M. Itoh	CYRIC, Tohoku Univ.	Researcher
T. Kawabata	CNS, Univ. of Tokyo	Assist. Professor
H. Matsubara	RCNP, Osaka Univ.	M2
K. Nakanishi	RCNP, Osaka Univ.	D3
P. von Neumann-Cosel	IKP, Tech. Univ. Darmstadt	Professor
I. Poltoratska	IKP, Tech. Univ. Darmstadt	Ph.D. student
V. Ponomarev	IKP, Tech. Univ. Darmstadt	Senior Researcher
A. Richter	IKP, Tech. Univ. Darmstadt	Professor
H. Sakaguchi	Dep. of Physics, Kyoto Univ.	Assoc. Professor
Y. Sakemi	RCNP, Osaka Univ.	Assoc. Professor
Y. Sasamoto	CNS, Univ. of Tokyo	M2
Y. Shimbara	NSCL, Michigan State Univ.	Researcher
Y. Shimizu	RCNP, Osaka Univ.	Researcher
F.D. Smit	iThembaLABS, Somerset West	Senior Scientist
Y. Tameshige	RCNP, Osaka Univ.	D2
M. Yosoi	RCNP, Osaka Univ.	Assoc. Professor
J. Zenihiro	Dep. of Physics, Kyoto Univ.	D1
K. Zimmer	IKP, Tech. Univ. Darmstadt	Ph.D. student

RUNNING TIME:

13.5 days

BEAM LINE:

Ring : WS course

BEAM REQUIREMENTS:

Type of particle:	$\vec{p}$ at 300 MeV
Beam intensity:	$\geq$2 nA
Beam polarization:	$\geq$0.7
Other requirements:	High-resolution halo-free beam with small emittance

BUDGET:

Experimental expenses	850 kyen
Travel planes	500 kyen

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SPOKESPERSON: Atsushi Tamii

SUMMARY OF THE PROPOSAL

We propose to measure $M1$ and $E1$ excitations in ^{208}Pb by high-resolution (p, p') scattering at zero degrees and forward angles.

The ^{208}Pb is the most important nucleus for discussing various strength distributions, nuclear responses, and mean field calculations since it is the heaviest stable nuclei which has a simple double-closed shell structure. The $M1$ strength distribution is closely related the quenching problem of the GT strength. The quenching of the $M1$ strength has long been discussed and many theoretical models have been presented. The $E1$ strength in ^{208}Pb has recently been much discussed with respect to the structure of the pygmy dipole resonances and exotic vortex type excitation with a toroidal current.

Experimentally, the strengths have been studied by combining many reaction data such as (γ, γ), (γ, n), (n, n), and (γ, n). However, even in each experiment, much systematic uncertainty remained in efficiency calibrations, spin-parity assignments, treatment of multiple decay channels and cascade decays, etc. By using the (p, p') scattering at very forward angles, we can probe $M1$ and $E1$ excitations in a 'single shot' measurement both above and below the neutron emission threshold with essentially no energy dependence of the efficiency and without being bothered by the complex decay mechanisms.

Actually (p, p') measurements were performed in 1980's. At that time, however, the experimental background was enormous and the most forward angle was 2-3 degrees. This experimental situation allowed criticism of the background estimation procedure and contamination by $M2$ strengths.

Thanks to the development of high-resolution (p, p') measurements at forward angles, we have successfully shown the feasibility of measuring (p, p') reactions from ^{208}Pb at zero

degrees, with a much smaller background condition in addition to a reliable background subtraction technique, with an excellent energy resolution of 20 keV, and a good scattering angle resolution. Now the energy resolution is comparable or even better than (γ, γ) measurements in this energy region. Moreover, polarization transfer coefficients provide a model-independent decomposition method of spin-flip ($M1$) and non-spin-flip ($E1$) excitations.

All the experimental requirements have now been accomplished. We just need to start the measurement.