RCNP EXPERIMENT E306

PROPOSAL FOR EXPERIMENT AT RCNP

12-July-2007

TITLE:

Search for narrow Gamow-Teller states in the A=4 nuclei

SPOKESPERSONS:

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EXPERIMENTAL GROUP:

Name	Institution	Title or Position
T. Adachi	RCNP, Osaka Univ.	PD
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K. Hatanaka	RCNP, Osaka Univ.	Professor
M. Kato	RCNP, Osaka Univ.	M2
T. Kawabata	CNS, Univ. of Tokyo	Assist. Professor
H. Matsubara	RCNP, Osaka Univ.	D2
H. Okamura	RCNP, Osaka Univ.	Professor
H. Sakaguchi	Dep. of Applied Physics, Miyazaki Univ.	Professor
Y. Shimbara	Dep. of Physics, Niigata Univ.	Assist. Professor
K. Suda	RCNP, Osaka Univ.	PD
Y. Tameshige	RCNP, Osaka Univ.	D3
M. Yosoi	RCNP, Osaka Univ.	Assoc. Professor

THEORY GROUP:

H. Toki	RCNP, Osaka Univ.	Professor
E. Hiyama	Dep. of Physics, Nara Women's Univ.	Assoc. Professor
T. Myo	RCNP, Osaka Univ.	PD
Y. Ogawa	RCNP, Osaka Univ.	PD

RUNNING TIME:

4 days + 3 day of beam tuning time

BEAM LINE:

Ring : WS course

BEAM REQUIREMENTS:

Type of particle:	^{3}He at 420 MeV
Beam intensity:	$\geq$20 enA
Other requirements:	High-resolution achromatic beam
Type of particle:	p at 400 MeV
Beam intensity:	$\geq$5 nA
Other requirements:	High-resolution halo-free achromatic beam with small emittance

BUDGET:

Experimental expenses	400 kyen
Travel fee	240 kyen

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SPOKESPERSONS: Atsushi Tamii and Yoshitaka Fujita

SUMMARY OF THE PROPOSAL

We propose to measure the ^{4}He(^{3}He, t) reaction and the ^{4}He(p, p') reaction at a scattering angle of 0° to search for narrow GT strengths in the A=4 nuclei. The GT giant resonances are found to be composed of many narrow (∼100 keV) states in the $sd-$ and $pf-$shell region. The origin of this narrow structure well above the particle-decay threshold is not clear. One of the possible explanations is the ground state correlation originating from the strong tensor force due to the pion-exchange at high momentum-transfer region, which is incorporated in conventional shell-model calculations in an averaged way.

In a simple shell-model prediction, no GT (1^+, T=1) strength is expected in the LS closed nuclei, e.g. ^{40}Ca, ^{16}O, and ^{4}He, but actually they are found in ^{40}Ca and ^{16}O. Up to now there is no indication of a GT strength nor a narrow ($<$ 500 keV) excited state in the A=4 nuclei. The possible existence of a narrow strength in the A=4 system is of much interest. Recently theoretical studies are much progressing to development a new method to explicitly incorporate the pion effect in nuclei and to calculation a four nucleon system with realistic nucleon-nucleon interaction. Since conventional theoretical models do not predict narrow excited states in ^{4}He, a dedicated experimental search is important to assess the validity of the theoretical models which are trying to explain the narrow structures found in heavier nuclei. In addition, the existence of GT strength has a great impact on the simulation of the delayed explosion of Type-II supernovae, for which no numerical simulation has succeeded in realizing the explosion.

Many measurements have been done for the study of excited states in the A=4 nuclei. Most of them were, however, not motivated to measure narrow states, and thus the energy resolutions were poor. A dedicated experiment with careful experimental consideration is indispensable to search narrow states with probably a small cross section. The proposed experiment will be performed with the highest sensitivity ever been done to narrow GT states at a level of much better than B(GT)=0.01.