RCNP EXPERIMENT E300

PROPOSAL FOR EXPERIMENT AT RCNP

06/02/2007

TITLE: Systematic study of (p,n) reactions on light nuclei at 350 MeV

SPOKESPERSON:

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EXPERIMENTAL GROUP:

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S. Kuroita	Kyushu Univ.	M	T. Sugimoto	Kyushu Univ.	M
K. Hatanaka	RCNP	P	H. Okamura	RCNP	P
A. Tamii	RCNP	AP	Y. Tameshige	RCNP	D
H. Matsubara	RCNP	D	M. Kato	RCNP	M
Y. Sakemi	CYRIC	P	K. Sekiguchi	RIKEN	R

RUNNING TIME:

Development of (p,n) measurement	3.0 days
Calibration of NPO,L3	1.0 day
Measurement of σ and A_y	4.0 days
Measurement of elastic scattering	1.0 day
Measurement of $D_{ii}(0^\circ)$	4.0 days
Total	13.0 days

BEAM LINE: WS and N0 (WS + GR + NPOL3/N0 + NPOL3)

BEAM REQUIREMENTS:

Type of particle	Polarized Protons
Beam energy	$\simeq$ 350 MeV
Beam intensity	$>$ 500 nA on target before pulse selection
Time resolution	$<$ 300 ps (FWHM)
Beam polarization	$>$ 0.7
Injection Mode	High Current Mode
Pulse selection	1/9 or 1/2

BUDGET:

Summary of budget request	4,700,000
Experimental expenses	3,900,000
Travel plan	800,000

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SUMMARY OF THE PROPOSAL

We propose to measure (p, n) reactions on ^{3}He and ^{4}He at $T_p \simeq$350 MeV. The data with the existing ^{2}H(p, n) data provide the systematic data for (p, n) reactions on light nuclei of A=2–4 at $T_p \simeq$350 MeV where the reaction mechanism is expected to be simple and a distorted wave impulse approximation (DWIA) is reliable.

For ^{4}He, an unexpected enhancement of the cross section has been observed in the quasielastic (QE) scattering at T_p=197 MeV. This enhancement might be a signature of high density (> normal density) effects of ^{4}He which are not included in present standard theoretical calculations such as DWIA calculations employing random phase approximation (RPA) response functions and a density-dependent effective nucleon mass. One of these effects is the reduction of hadron mass and coupling constant with nuclear density as a signature of partial restoration of chiral symmetry in nuclear matter. However, there are ambiguities in theoretical calculations and their interpretations since the reaction mechanism might be complicated at high energy transfers ($T_n \lesssim$100 MeV) of ^{4}He(p, n) at T_p=197 MeV. The reaction mechanism should be more simple at $T_p \simeq$350 MeV. Thus the data at $T_p \simeq$350 MeV will provide clear and useful information on high density effects in nuclear matter, and a characterization of these effects is expected to be crucial for understanding relativistic heavy ion collisions and neutron stars.

For ^{3}He, our data will provide the information on both the $T = 3/2$ resonance in the three-nucleon system and the $T = 3/2$ three-nucleon forces. We can also refine the understanding for the structure and reactions of light nuclei (e.g. QE peak shift) because systematic data for (p, n) reactions on ^{2}H (RCNP-E59 and E131), ^{3}He and ^{4}He (this proposal) at the same incident energy of $T_p \simeq$350 MeV and the reaction angles become available.