RCNP EXPERIMENT E312

PROPOSAL FOR EXPERIMENT AT RCNP

14 February 2008

TITLE:

Study of relativistic effects via the measurement of the proton-deuteron breakup around quasi-free-scattering configurations at $E_p = 200$ MeV

SPOKESPERSON:

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EXPERIMENTAL GROUP:

Name	Institution	Title or Position
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K. Suda	RCNP, Osaka University	PD
Y. Tameshige	RCNP, Osaka University	D3
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D. Ishikawa	RCNP, Osaka University	M1
H. Sakai	Department of Physics, U. of Tokyo	P
K. Yako	Department of Physics, U. of Tokyo	RA
H. Kuboki	Department of Physics, U. of Tokyo	D3
M. Sasano	Department of Physics, U. of Tokyo	D3
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K. Miki	Department of Physics, U. of Tokyo	M2
T. Wakasa	Kyushu University	AP
Y. Maeda	Kyushu University	RA
M. Dozono	Kyushu University	D1
H. Witała	Jagiellonian University, Poland	P

RUNNING TIME: 6.5 days

BEAM LINE: Ring: WS course, Grand Raiden & LAS

BEAM REQUIREMENTS:

Type of Particle	proton
Beam Energy	200 MeV
Beam Intensity	10-20 nA
Energy Resolution	$\leq$ 300 keV

BUDGET:

Experimental expenses 100,000 JPY

Traveling expenses : 10 people should be supported by RCNP.

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SUMMARY OF THE PROPOSAL

A hot topic in the study of few-nucleon systems is to learn how important are 3NFs and what are their properties. Both the nucleon-deuteron (Nd) elastic scattering and deuteron breakup reaction are taken as very efficient tools for that. To learn about 3NFs it is necessary to find out how these forces are sensitive to different observables in Nd elastic scattering and deuteron breakup reaction. In this respect it is important to find out how large are complementary effects which could interfere with signals from 3NFs. Because the effects of 3NFs grow with increasing energy of the 3N system it is important to have relativistic effects in both processes well under control. However, it became possible only recently to perform relativistic 3N Faddeev calculations for the Nd elastic scattering and deuteron breakup reaction. It has turned out, that at higher energies of the 3N system effects of relativity only slightly influence the Nd elastic scattering cross section. Contrary, for the deuteron breakup reaction its rich phase-space offers numerous complete configurations for which both large as well as small effects of relativity on the cross section have been found. These theoretical predictions must be verified experimentally in order to use these processes as a tool for study of 3NFs.

We propose to measure the cross sections of the kinematically complete proton-deuteron (pd) breakup at an incoming proton energy 200 MeV. The configurations of interest are $(\theta_1, \theta_2, \phi_{12}) = (42.5^\circ, 37.5^\circ, 180^\circ)$, $(47.5^\circ, 37.5^\circ, 180^\circ)$, $(57.5^\circ, 60^\circ, 180^\circ)$ which are around the so called quasi-free-scattering (QFS). In these particular geometries of three outgoing nucleons large changes of the cross section of up to $\approx 50\%$ due to relativity have been predicted. On the other hand these cross sections are extremely insensitive to changes between modern nucleon-nucleon (NN) potentials, combining them or not with 3NFs. These data will provide for the first time a stringent test of relativistic effects in the 3N scattering.

We also measure the absolute cross section for elastic pd scattering at 200 MeV which is used for absolute normalization of the breakup cross sections. In addition we measure the angular distribution of the cross section in order to complete the data base of pd elastic scattering at 200 MeV and then provide the solid base of 3NF study.