RCNP EXPERIMENT E178

PROPOSAL FOR EXPERIMENT AT RCNP

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TITLE:
Ultra Cold Neutron Production Experiment

SPOKESPERSON:

Name	Yasuhiro Masuda
Institution	Institute of Particle and Nuclear Studies, KEK
Title or Position	Associate Professor
Address	1-1 Oho, Tsukuba-shi, 305-0801, Japan
Phone number	0298-64-5617
FAX number	0298-64-3202
E-mail	yasuhiro.masuda@kek.jp

EXPERIMENTAL GROUP:

Name	Institution	Position
Kimio Morimoto	Institute of Particle and Nuclear Studies, KEK	P
Shigeru IshimotoK	Institute of Particle and Nuclear Studies, KEK,	RA
Suguru Muto	Institute of Material Structure Science, KEK	RA
Takashi. Ino	Institute of Material Structure Science, KEK	RA
Yoshiaki Kiyanagi	Dep. of Nuclear Engineering, Faculty of Engineering, Hokkaido Univ.	P
Toshio Kitagaki	Dep. of Physics, Faculty of Science, Tohoku Univ.	P
Masato Higuchi	Dep. of Applied Physics, Faculty of Engineering, Tohoku Gakuin Univ.	P
Kichiji Hatanaka	RCNP, Osaka University	P
Mishima Kenji	RCNP, Osaka University	D2
Masato Yoshimura	RCNP, Osaka University	Laboratory Fellow
Robert Golub	Hahn Meitner Institut, Germany	Laboratory Fellow
Masayoshi Tanaka*	Kobe-Tokiwa Collage	P

RUNNING TIME:

Installation time without beam	2 months
Development of device	14 days
Test running time for experiment	14 days
Data runs	14 days

BEAM LINE: Ring : ES course

BEAM REQUIREMENTS:

Type of particle	protons
Beam energy	400 MeV
Beam intensity	as high as possible

BUDGET:

Experimental expenses — see page 25 of Proposal

*under discussion

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SUMMARY OF THE PROPOSAL

A new ultra cold neutron (UCN) production in a spallation neutron source is proposed. The new method uses phonon excitation in He-II, where we can use large phonon phase-space for neutron cooling. The new method is free from Liouville's theorem, which limits the UCN density in the previous UCN sources, like the turbine UCN source at Grenoble which is the most intense UCN source. The spallation neutron source has an advantage in small γ heating in the He-II compared with the reactor.

The UCN density is obtained by the product of a production rate and a storage time. The storage time is limited by a phonon up-scattering in He-II, a wall up-scattering in a UCN bottle and a neutron absorption. No neutron absorption in He-II. The phonon up-scattering rate depends on He-II temperature, which becomes comparable to the β-decay rate at ¡ 0.8 K. Therefore, small γ heating is essentially important to obtain high UCN density. A 12-kW spallation neutron source realizes a thermal flux of $\sim 4 \times 10^{11}$ n/ s·cm^2 in He-II with 3-W γ heating in He-II. The heat load of 3 W can be removed by a usual ^{3}He cryostat.

The thermal flux is fairly intense for the UCN production. The UCN production rate depends on a neutron flux at the intersection point of the energy-momentum dispersion curves of the neutron and He-II phonon. The flux at the intersection point depends on a neutron temperature. We can improve the production rate by factor 10 to 100 at lower neutron temperature in a cold neutron moderator compared with in a thermal moderator. If we assume a neutron storage time of 300 s, which is limited by the wall up-scattering, the UCN density will be $3 \times 10^{3-5}/\mathrm{cm}^3$. The lowest number is for the thermal moderator. We will use a 400-MeV proton beam at RCNP for the spallation neutron production. The present maximum proton current is 1 μA, therefore, the UCN density and the heat load are reduced by factor 30. In the experiment, we will measure the UCN density for future UCN experiments.

Contents of the present proposal are