Ultra Cold Neutron Production Experiment

Y. Masuda,[a] S. Ishimoto,[a] K. Morimoto,[a] S. Muto,[a] Y. Kiyanagi,[b] M. Ooi,[b] M. Tanaka,[c] E. Choi,[d] K. Mishima[d] and M. Yoshimura[d]

[a]*KEK, 1-1 Oho, Tsukuba-shi, Ibaraki 305-0801 Japan*
[b]*Hokkaido University, Sapporo-shi, Hokkaido 060-0808 Japan*
[c]*Kobe Tokiwa Collage, Kobe-shi, Hyogo 653-0838 Japan*
[d]*Research Center for Nuclear Physics, Osaka University, 10-1, Mihogaoka, Ibaraki-shi, Osaka 567-0047, Japan*

A new ultra cold neutron (UCN) production in a spallation neutron source has been investigated.[1, 2] 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 UCN density of the new method is limited by a g heating in He-II. The spallation neutron source has an advantage in small g heating compared with the reactor.

We have carried out a feasibility study for the UCN production. 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 b-decay rate at < 0.8K. Therefore, small g heating is essentially important to obtain high UCN density. We expect a 12-kW spallation neutron source realizes a thermal flux of $\sim 4 \times 10^{11}$ n/s^2 in He-II with 3-W γ heating in He-II. The heat load of 3W 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 300s, which is limited by the wall up-scattering, the UCN density will be $3 \times 10^{3 \sim 5}$ /cm^3.[3, 4] The lowest number is for the thermal moderator. We are constructing the UCN source for a medium energy proton beam line. The construction of a spallation target, neutron moderators, a He-II cryostat is almost finished. We will carry out a UCN production experiment in the medium energy proton beam line for future UCN experiments.

References

[1] Y. Masuda, Nucl. Instr. Meth. **A440** (2000) 682.
[2] M. Ooi, T. Kamiyama, Y. Masuda, and Y. Kiyanagi, Proc. ICANS-XV, KEK Proceedings **2000-22** (2001) 1086.
[3] Y. Masuda, S. Ishimoto, K. Morimoto, S. Muto, Y. Kiyanagi, M. Ooi, M. Tanaka, E. Choi, K. Mishima, and M. Yoshimura, Proc. ICANS-XV, KEK Proceedings **2000-22** (2001) 1067.
[4] K. Mishima, M. Ooi, E. Choi, Y. Kiyanagi, Y. Masuda, S. Muto, M. Tanaka and M. Yoshimura, Proc. ICANS-XV, KEK Proceedings **2000-22** (2001) 1094.