HAW09-2009-020041

Abstract for an Invited Paper
for the HAW09 Meeting of
the American Physical Society

He-II UCN source in Japan and Canada

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Ultracold neutrons (UCN) can be confined in a material/magnetic bottle. This unique property is very useful for various kind of experiments, for example neutron EDM, β decay and gravity experiments. Confined neutrons distribute in a phase space with equal weight. A phase space density is one of the most important parameter for the experiments. In the traditional UCN source like the turbine UCN source at Grenoble, the phase space density is limited by Liouville's theorem. We use phonon phase space of superfluid helium (He-II) for neutron cooling, where neutron phase space density is not limited by Liouville's theorem. UCN density in He-II is represented as the product of a UCN production rate, which is the product of a production cross section and an incident neutron flux, and a UCN storage lifetime. The UCN storage lifetime is very long in He-II. We constructed a He-II spallation UCN source in a 392 MeV 1 μA proton beam line at RCNP. He-II was placed in a cold neutron source. UCN, which were produced in the He-II, were transported to an experimental volume through UCN guides. We obtained a UCN density of 15/cm^3 at an experimental port, where the maximum UCN energy was 90 neV. The UCN density is large compared with the turbine UCN source. We are constructing a new UCN source based on the experiment at RCNP. We will increase the UCN production rate by better coupling between the He-II and the cold neutron source. We will increase the UCN storage lifetime and transport efficiency from the UCN production volume to the experimental volume. We will place the new UCN source at TRIUMF, where we can use a 500 MeV 40 μA proton beam. We expect the improvement of UCN density by three order of magnitude.