A Comment on the Ultra Cold Neutron Session

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The application of Ultra Cold Neutrons to the fundamental physics and the applied physics has drawn considerable attention in recent years. One of the present major problems of the study is how to produce a strong UCN source in space and time. The Liouville's theorem states that unless the energy-non-conserving external force is applied, the phase space density of UCN is equal to that of source neutrons. The allowed volume of UCN in velocity space is minute, in the order of 7 m/sec in radius. It is however important to note that this limit on the density can be lifted by introducing whatever an externally controlled cooling device which functions in accordance with the velocity coordinates of the source neutrons in bringing them down to the UCN region. This principle has been applied to "stochastic cooling" in the field of high energy physics to increase the luminosity of particle beam in a storage ring. The velocities of source neutrons prior to cooling can be easily known by TOF method. Thus an attractive possibility to produce UCN in conjunction with the pulsed neutron source opens up. Utsuro at University of Kyoto in fact tested such a device, where a magnetic bottle produced by a series of solenoids traveled along its axis while it was decelerating its own speed. The rate of deceleration was carefully adjusted to match the arrival of slower neutrons. He claimed the observation of polarized UCN. It is hoped that any UCN production device which functions periodically as presented in the first two papers here should have the same end. In the present particular contribution, Dombeck, after his successful production of UCN by Doppler-shifted Bragg scattering, showed that by placing a blind which was fashioned out of triangular sections of stainless steel perpendicular to the motion of the crystal the spacial UCN density increased by a factor of three, and placing a copper reflector around the produced UCN cloud the collection efficiency increased by a factor of two. The acceptance energy width is 60 μeV at incident source neutron energy of 815 μeV. Utsuro reported the construction of a neutron turbine where each blade is assembled out of three pieces of supermirror which reflects neutrons totally whose perpendicular component of wavelength is 260Å or over. The acceptance

energy width is 5.2 μeV at 13 μeV. It is to be noted that both devices have high cooling efficiencies, which are essentially equal to reflectivities. The superthermal helium converter, proposed by Golub and Pendlebury, on the other hand works on the direct current basis (i. e. the device is always ready regardless of the neutron arrival time. Although the neutron turbine's duty cycle is nearly 100%, it should be classified into the category of periodic machine from its functioning.) Therefore the final UCN densities are limited by the Liouvulle's theorem. It has also a disadvantage of all neutrons not being converted to UCN because of the limited cross section of the process. The acceptance width is 45 μeV at 1038 μeV. However this scheme has some merits. Since the source neutron can penetrate into the helium vessel and the produced UCN can not leave it, the collection efficiency is high compared to the scheme where diffusing UCN cloud produced in space is trapped into a storage vessel by means of an opening shutter at the moment of UCN production. With the superthermal helium converter, the UCN density in the vessel thus stacks proportionally with time. Although this scheme looks at first best fit to the direct-current source neutrons from nuclear reactors, because of the heat, it is necessary to use the external beam. With the spallation source on the other hand this production device itself can be wrapped up with slabs of cold sources, if not the radiation in helium become too much a problem. The consequent gain in solid angle is in the order of 10^4 which compensates more than the loss due to duty cycle of the accelerator compared to the use of reactors. The third contribution deals with a test of a superthermal helium converter with an emphasis on the elimination of hydrogen contaminating the vessel.