Development of Neutron Doppler Shifter and UCN Accelerator

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Ultra cold neutrons (UCNs), whose kinetic energies are lower than about 300 neV, are useful probe in such precise experiments as the measurements of neutron lifetime, the tests of short-range gravity and the searches for neutron electric dipole moment (nEDM). However, there are few UCN sources in Japan and it is difficult to carry out quick R&D for these experimental apparatus.

Hence a neutron decelerator which removes the momentum of neutrons by Doppler effect [1] from one set of rotation monochromatic supermirrors has been developed. It is installed in BL05 beamline at J-PARC/MLF. It slows down neutrons about 136 m/s and generates 44 UCNs below 245 neV per second at 300 kW beam power. The pulse repetition rate of incident neutrons is 25.0 Hz and the rotation rate of the mirrors is 33.3 Hz. Accordingly the device produces pulsed UCNs and their repetition rate is 8.33 Hz.

At present a magnetic UCN accelerator has been developed with this source. Neutrons can be accelerated or decelerated through static magnetic fields finally if their magnetic moments are flipped in the fields [2]. When a RF spin flipper is combined with gradient magnetic fields and spin-flip timings are well controlled, diffusing UCN pulses are focused and rebunched at any points temporally [3]. This technique makes it possible to use high-density UCNs from pulsed spallation neutron sources effectively and increase storage number of UCNs. It is a great advantage in nEDM searches, lifetime measurements and so on.

References

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