Production of Ultra-cold Neutron (II)

M. Tanaka

Ultra-cold neutrons (UCN) with high density are one of the important tools in studying fundamental physics. Recently, the group from the LANL, USA succeeded in realizing the high density UCN over 100 UCN/cm^3 using a solid D_2 (sD_2) converter in the ortho state (I = 0, 2, where I is a total nuclear spin) and a spallation neutron source[1]. Encouraged with this success, we have started a basic study on the sD_2 converter aiming at construction of high intensity UCN source. One of the important subjects for this purpose is to study conversion of the ortho- to para-D_2 (I = 1) due to the radiation exposure since growing of the para- sD_2 induces reduction of the UCN storage time and consequently gives rise to reduction of the UCN density.

As the first step of our work, the above radiation effect on D_2 in a liquid phase was investigated instead of a solid phase because of easiness. The gamma-rays were generated by bombarding a 30-mm thick Ta target with 33-MeV electron beams (~5 kW) from the KURRI electron linear accelerator with a repetition rate of 100 Hz. An ortho liquid D_2 with concentration of 98.5% was kept at T = 25 K by a 2-stage Gifford- McMahon cryostat. The liquid ortho D_2 was irradiated during 35 hours by the gamma- rays with a heat deposition of about 150 mW/g which was comparable to the radiation level of the cold neutron source at PSI (SINQ) (~230 mW/g)[2]. The ortho D_2 concentration was measured by means of the Raman spectroscopy in which a 514.5- nm line from a 10-W Ar ion laser and a combination of 2 sets of monochrometers were used. Analyzing the observed D_2 molecular rotational bands of the irradiated samples, the ortho-D_2 concentration was found to be 91%. This unexpectedly large reduction rate seriously contradicts with the SINQ result [2]. A more precise measurement with an optimized condition and the theoretical interpretation of the observed results are now in progress.

References

[1] C. L. Morris et al., Phys. Rev. Lett. 89 (2002) 27250-1.

[2] K. Kirch, private communication.