# Development of the polarimetry with NMR for polarized HD target

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In the polarized Hydrogen-Deuteride (HD) target project [1], we plan to measure the double polarization asymmetries for the $\phi$ meson photoproduction. High polarization will be obtained by applying high magnetic field (17 T) at low temperature (10 mK). In the case of proton in HD, the polarization is expected to be 95 %. Accurate measurements of the target polarization are essential in this project. With this aim in mind, we are developing the polarimetry with "steady" NMR. When the magnetic field (or NMR frequency) is swept, an area of spectrum obtained from steady NMR signal is proportional to the target polarization.

As a first step, we have obtained NMR spectra of the liquid $H_2$ to check our NMR system with the single coil method, in which a single coil is used for both transmitter and receiver coils. When the single coil is used, one should construct an electronic circuit so that an rf signal from a transmitter does not mix with a signal from a receiver. Therefore, we used a cancellation circuit which is proposed by Jefferey and Armstrong [2] as shown in Fig. 1(a). We used a cylindrical sample cell made of Stycast1266 with an inner-diameter of 11 mm and a length of 28 mm as shown in Fig. 1(a). The NMR coil has a saddle shape and covers the whole region of the cell. The $H_2$ sample was liquefied at 17 K by "Storage Cryostat (SC)" which is a $^4$He cryostat with a superconducting magnet. The magnetic field was swept from 0.405 to 0.41 Tesla and the NMR frequency was fixed at 17.8 MHz.

Figure 1(b) shows the NMR spectra of the sample cell in which liquid $H_2$ is filled. The NMR spectrum consists of two parts; a sharp peak at 0.407 Tesla and a broad one around the sharp peak. We observed a broad peak even with an empty sample, which suggests that the broad peak is due to the proton in Stycast and the sharp peak comes from liquid $H_2$. The longitudinal relaxation time $T_1$ of NMR is related to the intensity of the signal and the transverse relaxation time $T_2$ is related to the line width. The line width of the sharp peak is consistent with the value estimated from the inhomogeneity of the magnet field in the sample cell, reflecting a long $T_2$ of the liquid $H_2$. On the other hand, the broad one reflects a short $T_2$ of Stycast. The signal of Stycast is quite large, which means that a proton system in Stycast has a short $T_1$. Thus, we will use a sample cell made of proton-free material, for example Kel-F to extract a clearer signal of the sample.

In the future, we will measure the polarization of solid HD target with this polarimetry.

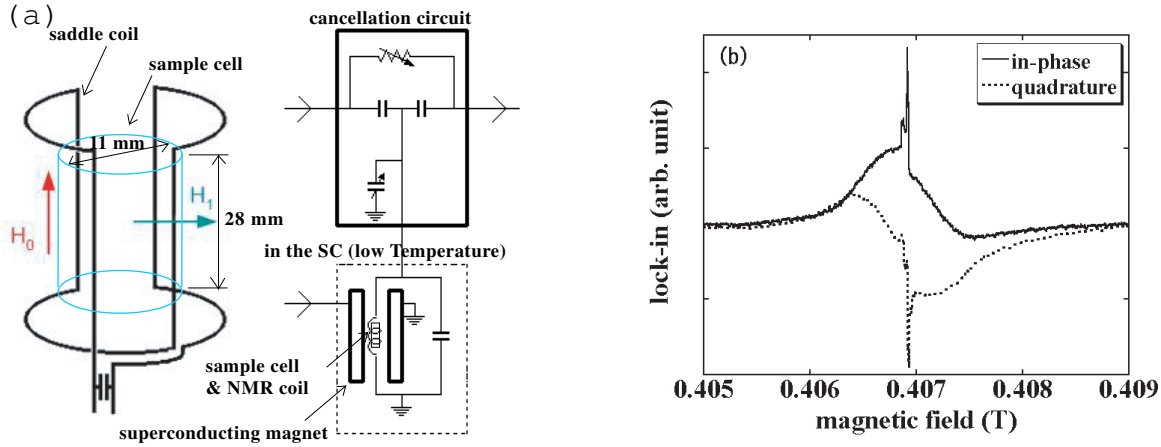


Figure 1: (a) The sample cell and the block diagram of NMR measurement. (b) The NMR spectra at 17 K and 17.8 MHz.

## References

[1] M. Fujiwara *et al.*, Photoproduction Experiment with Polarized HD Target at SPring-8, LEPS/RCNP proposal (2003).

[2] K.R. Jefferey and R.L. Armstrong, Rev. Sci. Instr. **38**, 634 (1967).