Development of Jamin Type Cold Neutron Interferometer with Completely Separated Two Paths

[1,4]Y. Seki, [1]K. Taketani, [2]H. Funahashi,
[3]M. Kitaguchi, [3]M. Hino, [4]Y. Otake, [5]H.M. Shimizu
Department of Physics, Kyoto University, Kyoto 606-8502, Japan
Osaka Electro-Communication University, 18-8 Hatsucho, Neyagawa, Osaka 572-8530, Japan
Research Reactor Institute, Kyoto University, Kumatori, Sennan, Osaka 590-0490, Japan
RIKEN, 2-1 Hirosawa, Wako, Saitama 351- 0198, Japan
KEK, 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan

We are developing large-dimensional cold-neutron interferometers with multi-layer mirrors in order to investigate small interactions.

The success of Jamin-type interferometer made up of two 'beam splitting etalons (BSEs)' [Fig. 1] with a 10 μm gap have confirmed the accuracy of manufacturing of etalons. However, even if the beam width was collimated to 100 μm, the two beams were almost overlapped. When we enlarge the gap of the BSE up to 200 μm, we can separate the beam spatially and realize various experimental configuration, for example, inserting the some devices between paths of the interferometer.

One of our experimental targets is the precision measurement of Aharonov-Casher effect. The AC effect is a dual of the Aharonov-Bohm effect. When a neutral particle with a magnetic moment goes around change density the topological phase shift is induced. The AC phase shift was detected for the first time by using the Si crystal neutron interferometer, however, the observed value was inconsistent with the expected value. Our large-dimensional cold-neutron interferometer with separated long paths can measure the topological AC phase shift precisely enough.

The development is performed at cold-neutron beam line MINE2 at JRR-3M reactor in JAEA. The beam has a wave length of 0.88nm and a bandwidth of 2.4% in FWHM. The typical longitudinal, vertical and horizontal coherence lengths in our setup are about 17 nm, 50 nm and 2 μm, respectively. Therefore the tolerances for alignment of two BSEs are

$$\alpha < 40 \quad \mu\text{rad}, \quad \beta < 130 \quad \mu\text{rad}, \qquad (1)$$

where α and β are the relative angle between two BSEs in the horizontal and vertical planes, respectively.

In order to arrange BSEs meeting this coherence condition, we have developed a new jig employing a precise planar substrate (SIGMA KOKI OFPXP-150S20-4). The 150-cm-square substrate is made of PYREX with flatness of $\lambda_{He-Ne}/4$. Each BSEs was fixed closely to the substrate at three points with screws. We have obtained reasonable signals of the interference fringe, and are trying to find a way to stabilize and improve its contrast.

In addition, we studied the thermal, magnetic and vibration stability in the experimental environment. It was understood that phase drifts of neutron spin interferometry ($\sim$ 34 mrad) were almost followed by the magnetic fluctuations ($\sim$ 16 mG).

References

[1] M. Kitaguchi *et al.*: Phys. Rev. **A 67** (2003) 033609.

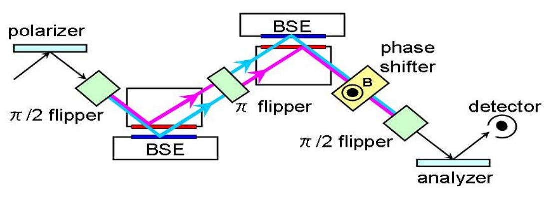

Fig. 1. Jamin-type interferometer with two BSEs