Development of cold neutron interferometer for pulsed source

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Neutron interferometry is a powerful technique for studying fundamental physics. A large dimensional interferometer for long wavelength neutrons has the advantage to increase the sensitivity to small interactions. Such a kind of interferometer was realized by using multilayer mirrors. Multilayer mirror is suitable for Bragg reflection of cold neutrons. We demonstrated Jamin-type interferometer for cold neutrons using beam splitting etalons (BSEs), which enables us to align the four independent mirrors within required precision [1]. The BSE contains two parallel mirrors. A couple of the BSEs in the Jamin-type interferometer separates and recombines the two paths spatially. A neutron supermirror is one of the multilayer with continuous lattice constants, which reflects the wide range of the wavelength of neutrons. The BSEs with neutron supermirrors enable us to arrange Jamin-type geometry of the interferometer for white neutrons. The interferometer can be applied to pulsed neutrons by using the BSEs with supermirrors. Such interferometer increase the neutron counts for high precision measurements, for example, Aharonov-Casher effect. Wevelength dependence of the interaction in the interferometer also can be measured by the time of flight detection for pulsed neutrons.

We have already performed test experiments using polychromatic mirrors with two different lattice constants. We fabricated two polychromatic mirrors with intermediate gap layer on the top of Si substrate continuously. This device enabled us to provide two separated paths of the Jamin-type interferometer for two wavelength of neutrons. We observed clear interference fringes at the two different incident angles, which were corresponding to the two multilayers in the polychromatic mirror, at cold neutron beam line MINE2 at the JRR-3 reactor in JAEA.

Polarization interferometer was used for the performed experiments. One of the two mirrors on the BSE is a polarizing mirror and each path corresponds to a spin component. We have installed the polarization devices into cold neutron beam line BL05 low divergence branch in MLF at J-PARC. We have observed TOF interference fringes for pulsed neutrons by using the devices which synchronized with neutron production, without BSEs. The experiments using BSEs with supermirrors are started now. We are also planning the experiments using the interferometer as one of fundamental physics investigations at J-PARC.

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

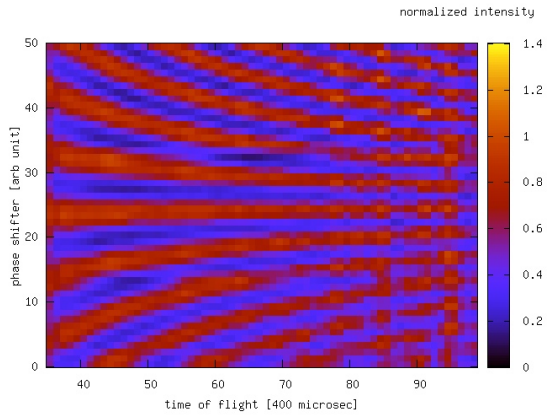

Fig. 1. TOF interference fringes at BL05 in MLF at J-PARC