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Cold neutron interferometry

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Neutron interferometry is a powerful technique for studying fundamental physics. A large dimensional interferometer for long wavelength neutrons is extremely important in order to investigate problems of fundamental physics, including tests of quantum measurement theories and searches for non-Newtonian effects of gravitation, since the sensitivity of interferometer depends on the wavelength and the interaction length. Neutron multilayer mirrors enable us to develop the large scale interferometer for long wavelength neutrons. The multilayer mirror is one of the most useful devices in cold neutron optics. A multilayer of two materials with different potentials is understood as a one-dimensional crystal, which is suitable for Bragg reflection of long wavelength neutrons. Cold and very cold neutrons can be utilized for the interferometer by using the multilayer mirrors with the proper lattice constants. Jamin-type interferometer by using beam splitting etalons (BSEs) has shown the feasibility of the development of large scale interferometer, which enables us to align the four independent mirrors within required precision. The BSE contains two parallel multilayer mirrors. A couple of the BSEs in the Jamin-type interferometer separates and recombines the two paths spatially. Although the path separation was small at the first test, now we have already demonstrated the interferometer with perfectly separated paths. This has confirmed that the multilayer mirrors cause no serious distortion of wave front to compose a interferometer. Arranging such mirrors, we are capable of establishing even a Mach-Zehnder type with much larger size. The interferometer using supermirrors, which reflects the wide range of the wavelength of neutrons, can increase the neutron counts for high precision measurements. We are planning the experiments using the interferometer both for the very cold neutrons and for the pulsed neutrons including J-PARC.