The interference of two widely separated coherent neutron beams produced by dynamical diffraction in a perfect Si-crystal has been observed. Phase shifting material inserted in the beams results in a marked intensity modulation behind the interferometer. Neutron interferometry introduces several new feasible experiments in nuclear and solid state physics.

Nearly all classical optical experiments have been extended to neutron beams; e.g. total reflection [1,2], slit diffraction [3], prima diffraction [4], diffraction on a color plate [5]. The first attempt to construct a neutron interferometer with coherent beams from a slit diffraction and a biprism diffraction proved only partially successful [6,8]. The diffraction pattern could be observed, but the coherence properties were destroyed by phase shifting material inserted into the beam. The main difficulties in that case came from the extremely small separation of the two coherent beams—about 60 μm only—and the rather small intensity caused by the narrow entrance slit of 10 μm.

Successful experiments with perfect crystal interferometers for X-rays [9–11] initiated the development of analogous neutron-interferometers [12,13]. The applicability of dynamical diffraction theory [14,15] to neutron beams is rather well established and confirmed by various experiments [16,17]. Because absorption is rather small, two wave fields are usually excited in the crystal.

A perfect silicon crystal with 80 μm diameter and 7 mm length (grown by Weiler-Chemtrop, Germany) was cut to give the appropriate plane-type interferometer as shown in fig. 1. The distance between the various interferometer parts (splitter S, mirror M and analyzer A) have to be very accurate to avoid defocussing effects and loss of coherence. After etching the thickness of the crystal plates confirmed by various experiments [16] to neutron beams is rather well established and

\[ \Delta \theta = \frac{D}{\lambda} \cos \left( \frac{B}{2} \right) \sin \left( \frac{B}{2} \right) \]

The measurements will be continued at high flux facilities and with strong dispersive arrangements to use the full capability of this interferometer. The statistical error is smaller than the size of the points.

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References