11.7-11 THICKNESS DEPENDENCE OF INTENSITY PROFILES IN A NEUTRON-STEP-INTERFEROMETER.

U. Kischko[1,2], U. Bonse[1], [1]Institut für Physik, Universität Dortmund; [2]Institut Laue-Langevin, F-38042 Grenoble, France

A new type of triple-Laue-case (LLL) interferometer with lamellas of different thickness (step-IFM) has been tested with the neutron-interferometer set-up at the ILL in Grenoble. Thermal neutrons of about 1.9 Å wavelength and Si-220 reflection were used. For an incident spherical wave the spatial intensity profiles as function of the geometric dimensions of a IFM have been developed theoretically by W. Bauspiess, U. Bonse, W. Graeff, J. Appl. Cryst. (1976) 9, 68. Contrary to the X-Ray case with strong Borrmann effect, for neutrons with extremely weak absorption both types of wave fieldes (type 1 with antinodes and type 2 with nodes on the crystal sites of the nuclei) have to be considered in the analysis. Spatial intensity concentration in the centre of the outgoing beams and good contrast properties are found if $t_M=2t_S=2t_A$, where t_M, t_S, t_A are thicknesses of mirror, beam splitter and

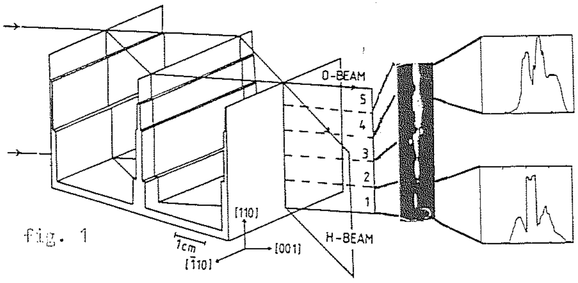

fig. 1

analyser, respectively. In our case (fig. 1) three regions (2,4,5) of the step-IFM with $t_M=t_S=t_A$ and two regions (1,3) with $t_M=2t_S=2t_A$ have been investigated (in regions 5,4,2: $t_M = 4.1\Delta_o$, $12.9\Delta_o$, $27.2\Delta_o$ and in 3,1: $t_M = 27.2\Delta_o$, $54.1\Delta_o$, respectively. Δ_o: extinction distance ≈ 65μm).
The interferometer was illuminated by a narrow beam. The divergence was sufficient to excite the whole Borrmann fan, so that the beam leaving the step-IFM covered a region of width 2T tan Θ_B $(T=t_S+t_M+t_A)$. The spatial intensity profiles in the O-beam were photographed by the ^{157}Gd conversion method. From the optical density the neutron intensity reaching the film was evaluated. Thus a comparison with theoretical profiles is possible.
The profiles show oscillatory structure in the O-beam which can be considered as a superposition of Pendellösung-oscillations of crystal plates with different thickness. Visible in the experiment are so far only the averaged intensities due to wavelength distribution and slit width. When compared with the experimental results the profiles agree reasonably with the calculated ones shown in fig. 1. Deviations are due to variations of focussing within a single region caused by geometrical aberrations which at present have not all been included in the calculations.
Clearly visible are the focussing properties of region 1 and 3 and the difference in the spatial intensity profiles of region 4 and 3 both in the experimental and in the theoretical profile.

Further results will be shown and discussed.

11.7-12 CREATION OF NEW WAVE-FIELDS - A THEORETICAL TREATMENT. By F.N. Chukhovskii, Institute of Crystallography, Academy of Sciences of the USSR, Moscow, USSR. F.Balibar and C.Malgrange (Lab. Minéralogie Cristallographie, Université P.etM. Curie, Paris, France)

The so-called creation of new wave-fields (or interbranch scattering) is a phenomenological explanation, operating in reciprocal space, of how the crystal wave is modified while propagating in highly distorted regions. It cannot be accounted for theoretically unless the Green function corresponding to the solution of Takagi's equations (Takagi, J. Phys. Soc. Japan (1969) 26, 1239) be itself expanded in reciprocal space. In the case of crystals with a uniform strain gradient normal to the entrance surface, this can be achieved by means of a Laplace transform. The h-Green function (Chukhovskii, Petrashen, Acta Cryst. (1977) A33, 311) then appears as a "non-planar wave-packet", i.e. a superposition of amplitudes $P_h(p)$ representing the non-planar wave that an incident plane wave of deviation parameter p will induce at a depth z in the distorted crystal. Apart from a multiplicative factor, $P_h(p)$ is in the form :

$$P_h(p) \propto \{D_\nu(-iY_o)\, D_{-\nu-1}(-Y) - D_{-\nu-1}(-Y_o)\, D_\nu(-iY)\}$$

where D_ν is the parabolic cylinder function of order ν.

$$\nu = i/4B \ ; \ Y_o = i\,\nu^{1/2} p \text{ and } Y = Y_o + 4\,\nu^{1/2} B \frac{\pi}{\Lambda} z$$

Λ : Pendellösung length.
B : measures the strain gradient $\left(B \propto \frac{\delta^2 (\vec{h}.\vec{u})}{\delta s_o\, \delta s_h}\right)$

The asymptotic limit of $P_h(p)$ for B >> 1 is made of 4 terms which are all different combinations of the phase factors $e^{\pm\frac{Y^2}{4}}$ and $e^{\pm\frac{Y_o^2}{4}}$. Two of them can be identified, through their phase, as the "normal" wave-fields of the Eikonal theory with tie-points staying on the same branch of the dispersion surface while the two others are shown to correspond to a "jump" of the respective tie-points from one branch of the dispersion surface to the other.

These are the newly created wave-fields. It should be noted that they originate in the region where the curvature of the normal trajectory is the largest, their amplitudes are both proportionnal to $e^{-\pi|\nu|}$ while the two normal wave-fields differ by a factor $(1-e^{-2\pi|\nu|})^{1/2}$ from what they could be if the Eikonal theory were valid. These results are in good agreement with previous predictions (F.Balibar, Y.Epelboin, C.Malgrange, Acta Cryst. (1975) A 31, 836).