

9.1 RECENT NEUTRON PHYSICAL EXPERIMENTS AT THE TRIGA MARK II REACTOR
VIENNA, H. Rauch, A. Zeilinger (Atominstitut der Österreichischen
Hochschulen, Vienna, Austria)

1. Experiments with polarized neutrons

The assembly for measurements with polarized neutrons at a beam hole of the Triga Vienna reactor uses $\text{Co}_{0.92}\text{Fe}_{0.08}$ single crystals in reflection position as polarizers and analyzers. The polarizing crystal can be rotated for deflecting the polarized neutron beam to different experimental setups.

Part of the work with polarized neutrons is done as transmission experiments. These experiments are mainly performed at the Curie temperature of ferromagnetic substances. Below T_C we have pronounced depolarization of the neutron beam because of the precession of the polarization vector of the neutrons within the ferromagnetic domains:

$$\frac{d\vec{P}}{dt} = \gamma \cdot \vec{P} \times \vec{B}$$

In particular earlier experiments on Dy /1,2/ were continued /3/. Dy is ferromagnetic below 85 K and has a helical magnetic structure between 85 K and 173 K. The phase transition at 85 K is of first order and associated with a heavy magnetostrictive effect. Furthermore T_C is field dependent. Stresses associated with the ferromagnetic phase transition have an influence on the transition in neighboring domains. This at first can be seen as a heavy broadening of the transition in polycrystalline material over more than 20 K. To clear this behaviour experiments on a Dy single crystal were performed. These experiments showed a sharp transition at the Curie temperature but some new inte-

resting features could be observed. At first we have seen a marked time dependence of the transition. Secondly two different Curie temperatures ($\Delta T_C = 2.1$ K) with raising or lowering temperature respectively were measured. This effect was also observed by elastic neutron diffraction. For more detailed revealing of the influence of the magnetostriction we also investigated polycrystalline samples tempered for different times. This showed a sharper transition for longer tempering times. Furthermore the existence of a mixed state of antiferromagnetic and ferromagnetic domains was cleared by observation of neutron depolarization by the strayfields of isolated ferromagnetic domains within the sample.

Further experiments under progress are made on Ni-samples for determination of the behaviour at T_C especially of critical parameters.

Recently /4/ a $\text{He}^3\text{-He}^4$ dilution refrigerator was installed at the beam. With this apparatus we can achieve a temperature of 20 mK and a maximum field of 1.5 Tesla at the sample by means of an asymmetric pair of superconducting Helmholtz coils. The usable beam diameter is 1 cm. The experiments planned are transmission of polarized neutrons through nuclear polarized Ho and Tb single crystals thus determining the polarization cross sections.

A neutron spin-flip chopper /5,6/ has been developed offering superior characteristics compared to the conventional r.f.-chopper. Flipping efficiencies of nearly 1.0 are achieved only by suitable DC-currents through the Mezei-coils. The chopping system consists of simple and reliable transistor switches operating in constant current mode. Fast on-off times (3 - 4 μs) are obtained because of the extremely low coil inductivity (3.5 μH) and delayed switching of the second coil according to the neutron time-of-flight through the first one resulting in an effective coil length of 1.5 cm. The good symmetry of

the neutron burst shape favours application of the correlation- as well as the Fourier-method.

2. Laue-type neutron interferometer

Recently at the Triga Vienna reactor a neutron interferometer was successfully tested /7,8/. An interferometer generally allows the division of a wave in two coherent parts which are brought together again for observing interferences. The neutron interferometer consists of an E-shaped ideal Si-crystal with 70 mm length. The reflection used was a symmetrical (002)-reflection. Before the interferometer an oriented graphite monochromator was used in a position that the main wave length of the reflected neutrons was $\lambda_0 = 2.04 \pm 0.02 \text{ \AA}$ and $\Delta\lambda/\lambda = 0.83 \%$. The interferometer crystal was arranged in a "parallel" position to the oriented graphite crystal.

The first plate of the interferometer crystal has the function of a beam splitter. Here the incoming beam is divided in two coherent waves with different directions. The second crystal plate is the "mirror", here these two beams are partially reflected. The reflected beams are interfering in the area where they cross over. The purpose of the last crystal plate is to analyse these interference by producing a Moiré pattern.

When a phase shifting material i.e. a substance with a mean potential for the neutrons not equal zero is put in one of the beams of the interferometer intensity variations in the transmitted and reflected beams can be observed. By use of Al and Bi as phase shifting materials the characteristic oscillations of the intensity of these beams were seen. From these oscillations the coherent scattering amplitudes of these materials were determined.

Further experiments planned concern very accurate determination of scattering amplitudes and neutron-electron contributions, measurement of inhomogeneities, of magnetic domain structures and on some basic problems of coherence of particle beams.

Literature

- /1/ H.Rauch, E.Löffler: Z.f.Phys. 210 (1968) 265
- /2/ H.Rauch, E.Seidl, A.Zeilinger: Z.f.angew.Phys. 32 (1971) 109
- /3/ H.Rauch, A.Zeilinger: Atomkernenergie 19 (1972) 167
- /4/ H.W.Weber: private communication
- /5/ G.Badurek, G.P.Westphal, P.Ziegler: Nucl.Inst.Meth. 120 (1974) 351
- /6/ G.Badurek, G.P.Westphal: submitted to Nucl.Inst.Meth.
- /7/ H.Rauch, W.Treimer, U.Bonse: Phys.Lett. 47A (1974) 369
- /8/ W.Bauspiess, U.Bonse, H.Rauch, W.Treimer: Z.f.Phys. in print.

- D1 Drossel $\lambda = 2,5 \text{ \AA}$, $\lambda = 2,5 \text{ \AA}$
- D2 Polarisator von Fe₃C
Neutronen $\lambda = 2,1 \text{ \AA}$
- D3 SF₆-Fluor-Chlorid
 $\lambda = 1,6 \text{ \AA}$
- D4, D5, D6 Neutronen-Cpolarisationsmessungen an magnetischen und supraleitenden Substanzen
Strukturuntersuchungen mit polarisierten Neutronen
 $\lambda = 1,1, 1,5, 2,2 \text{ \AA}$
- D6a monochromatischer Neutronenstrahl
 $\lambda = 2,2 \text{ \AA}$

- a Streifenkollimator ($\lambda = 2,2 \text{ m-n}$)
- b Co-Fe-Polarisator (140,25 x 3mm)
- c Co-Fe-Analytator
- d BF₃-Zählrohr
- e Probe
- f Shim
- g Resonanz-Spin-Flip
- h Drehsitz = 25°
- i Monitor-Zählrohr
- j magnetisches Führungsfeld
- k Laufrolle
- l Al - Einweistell
- [] Abschirmung

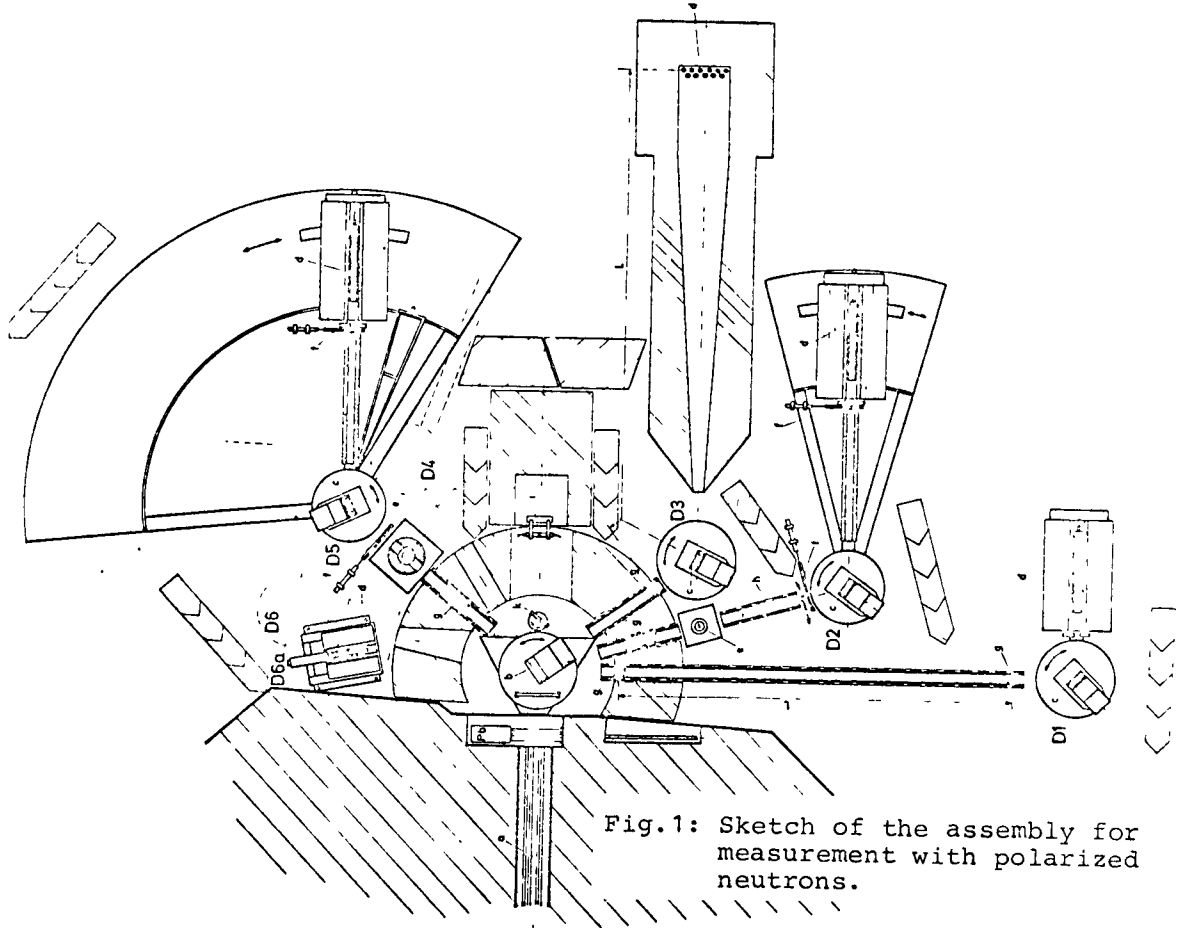
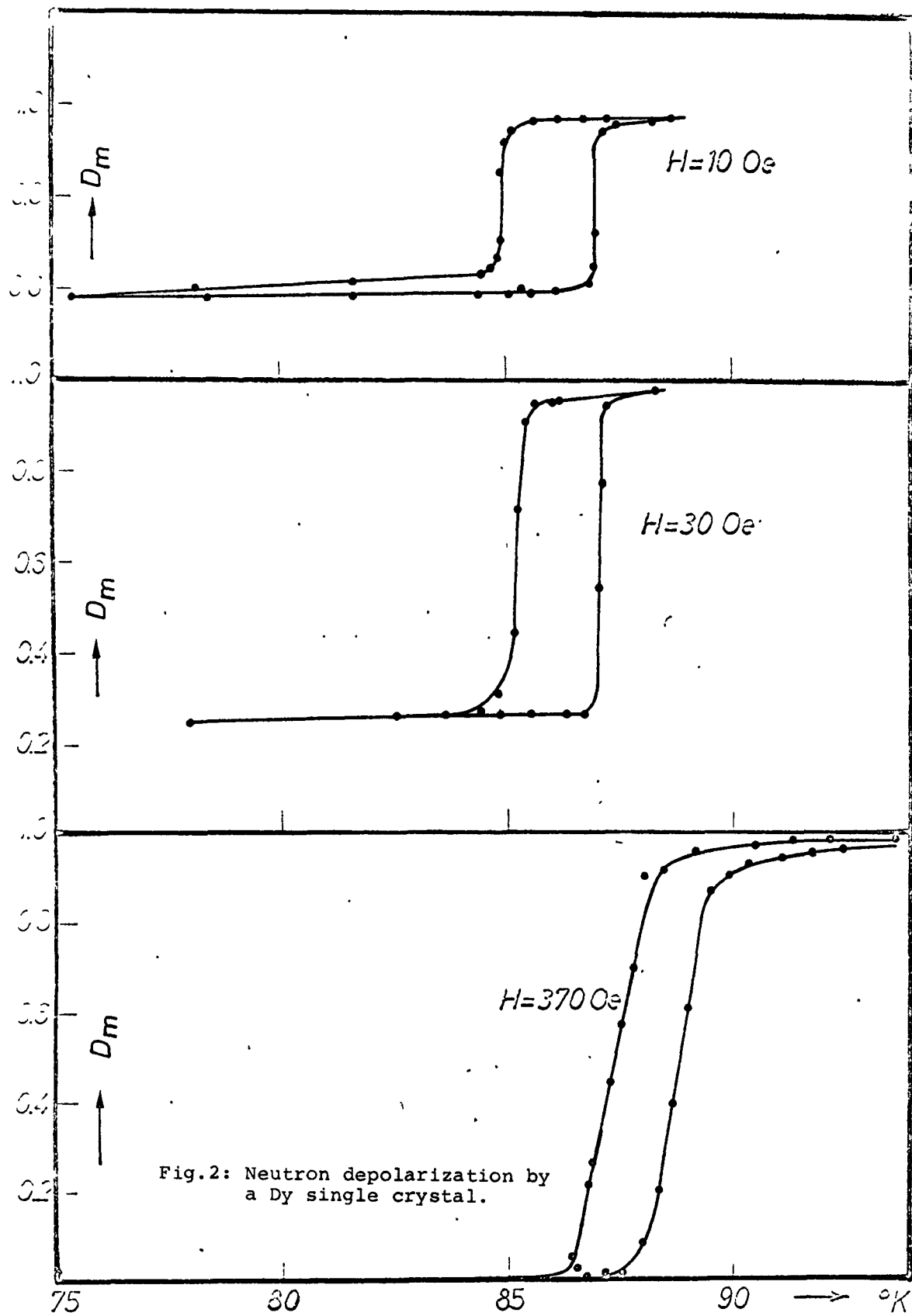


Fig.1: Sketch of the assembly for measurement with polarized neutrons.



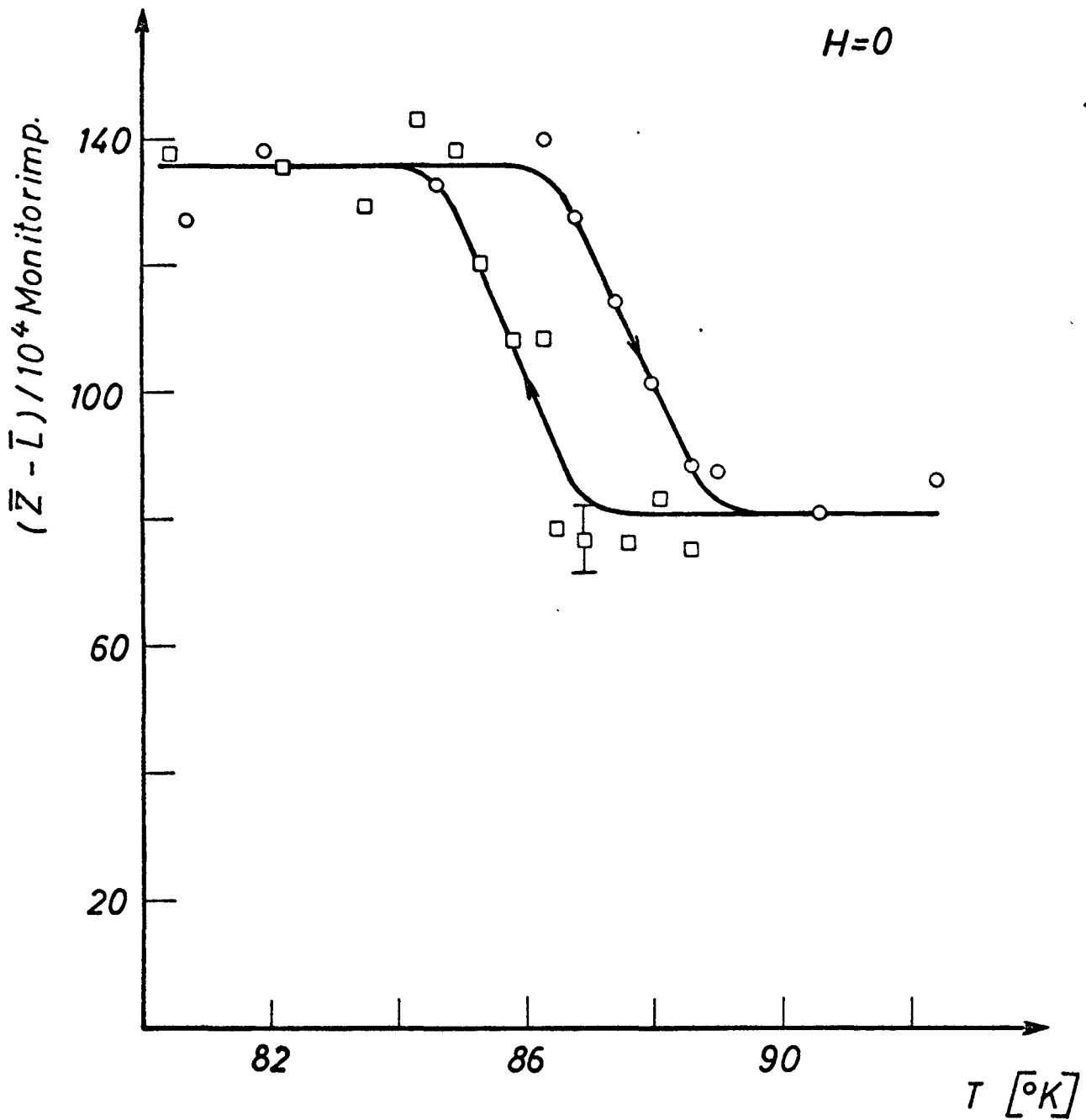
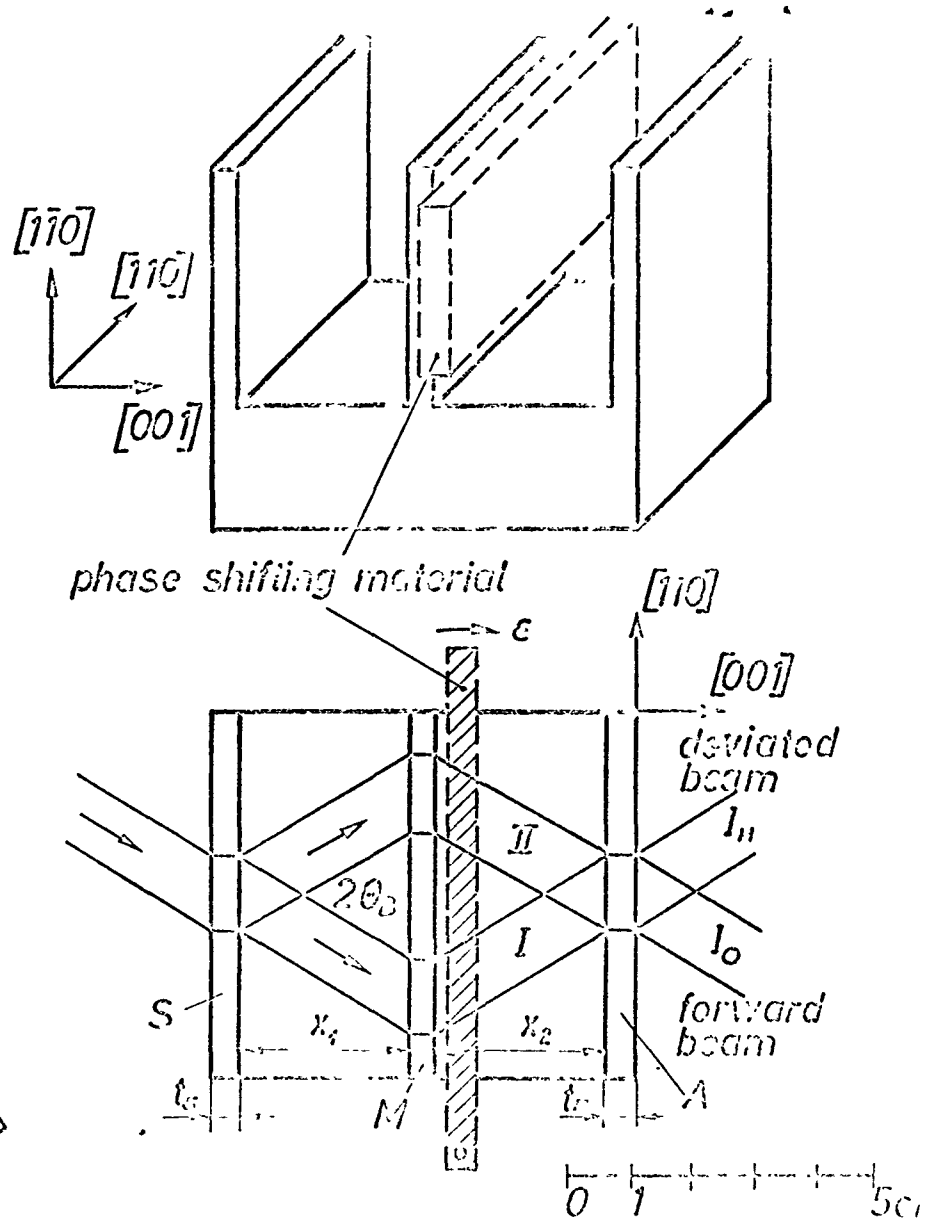
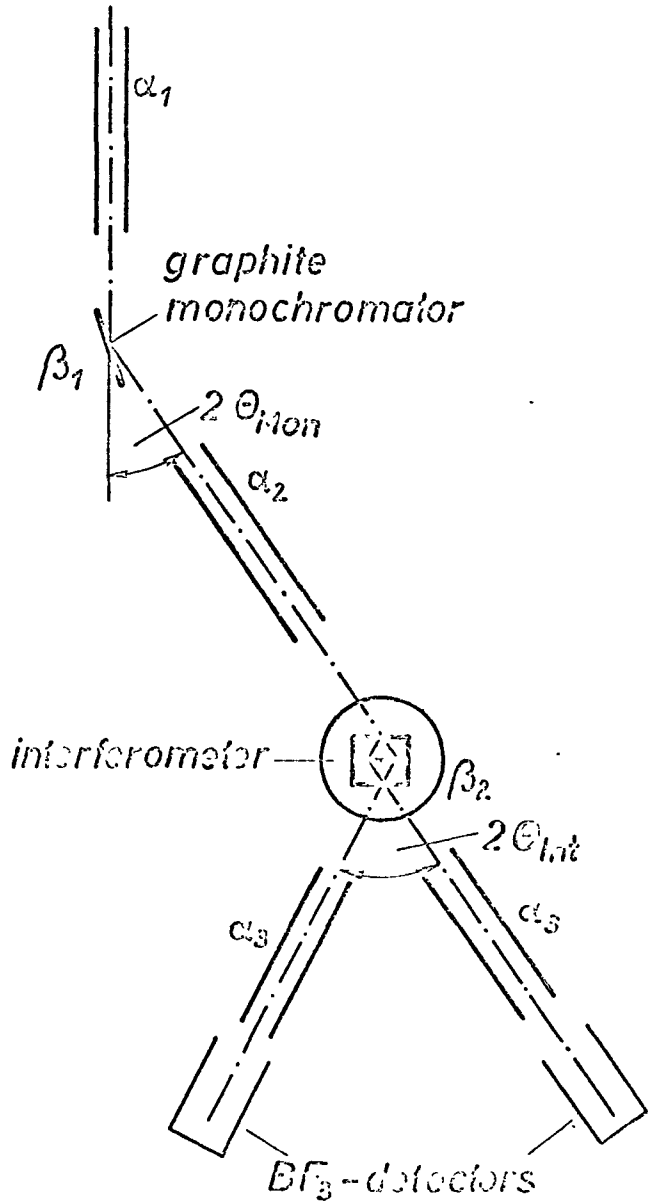


Fig.3: Elastic neutron diffraction from a Dy single crystal.

Fig. 4: Neutron interferometer: Sketch of the arrangement and of the interferometer crystal.



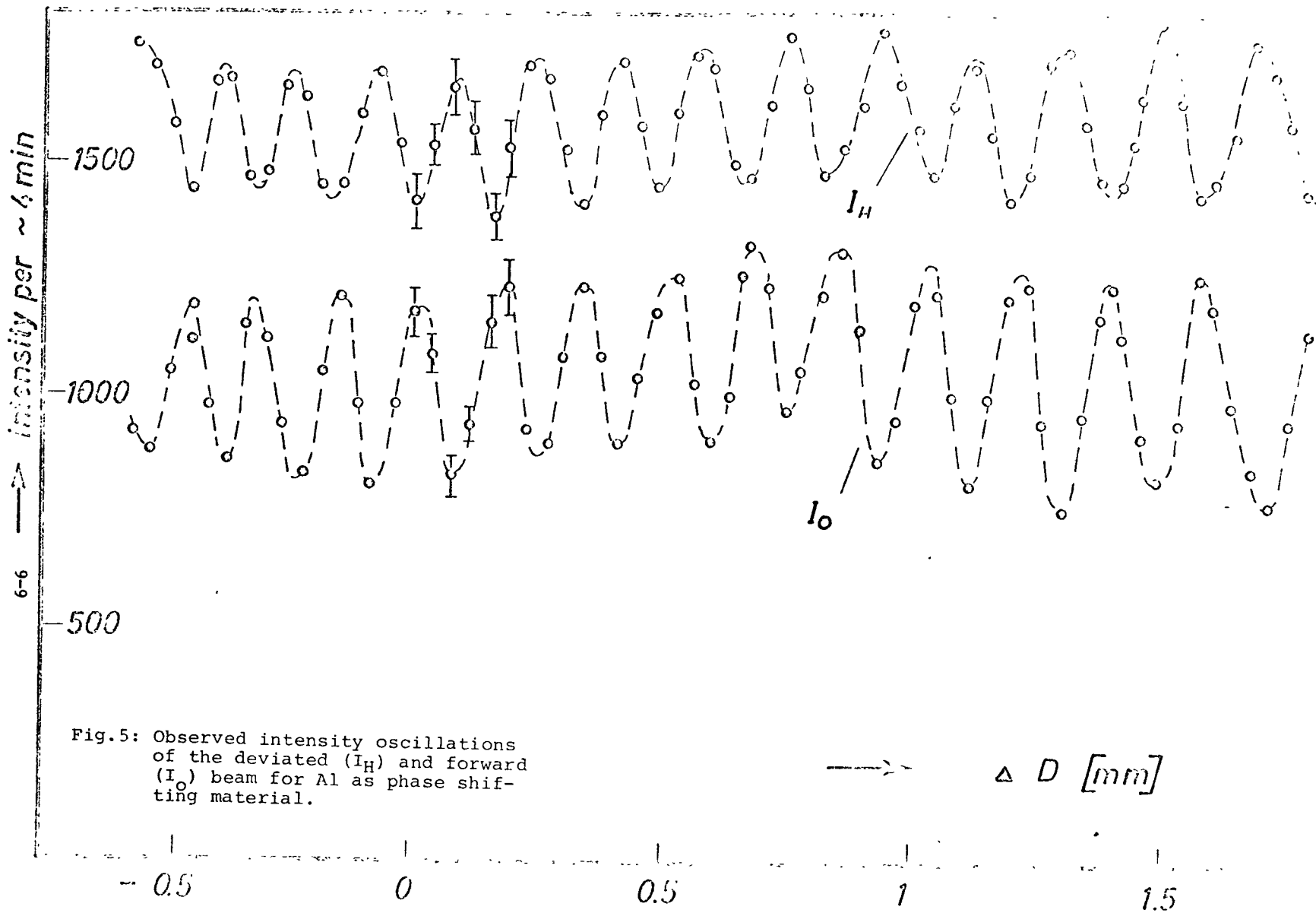


Fig.5: Observed intensity oscillations of the deviated (I_H) and forward (I_0) beam for Al as phase shifting material.