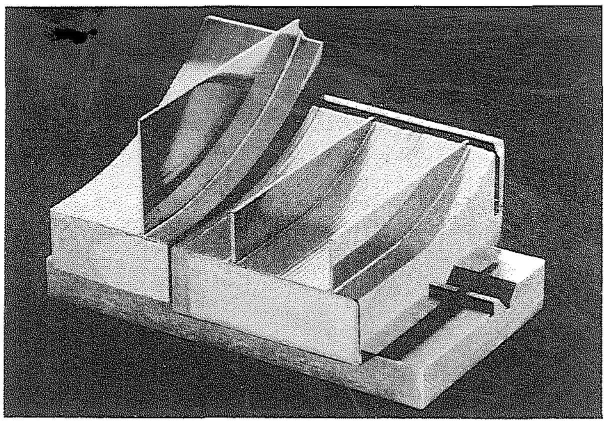
Figure : Two crystal X-ray interferometer, crystal parts cut from different silicon materials.



11.6–3 FRAUNHOFER DIFFRACTION OF DYNAMICALLY DIFFRACTED BEAMS IN DISTORTED CRYSTALS. By C. Malgrange, Laboratoire de Minéralogie-Cristallographie, Université Pierre et Marie Curie, Paris, France and J. Gronkowski, University of Experimental Physics, Varsaw, Poland.

Diffraction by a slit is a well-solved problem in classical optics where homogeneous media are considered. An incident plane-wave of wavelength λ going through a slit of width e, gives, over a distance of the order λ^2/e, a beam of constant width e, slightly perturbed by Fresnel diffraction. At larger distances, the beam diverges with a Fraunhofer angular half width equal to λ/e.
It has been shown (A.Authier, C.Malgrange, C.R. Acad.Sc. Paris, (1966), 262, 429) that for an X-ray plane wave at Bragg incidence on a perfect crystal, the same phenomena occur but with a magnification of the order of Λ/λ (Λ means the extinction distance) resulting from the angular magnification in the crystal. Consequently, the distance at which the beam diverges is then of the order of e^2/Λ.
The aim of this work is to show how diffraction acts on the propagation of an X-Ray beam at Bragg incidence in a slightly distorted crystal. Computer experiments have been performed using Takagi's equations in the Bragg case and for a constant strain gradient. The results obtained for various values of the departure from exact Bragg incidence, the strain gradient and the slit width can be interpreted by extending to distorted media the following argument working in media of constant refraction index : Fraunhöfer diffraction occurs at distances from the slit at least equal to the distance at which the Fraunhofer image is wider than the width of the slit.

11.6–4 X-RAY DIFFRACTION IN A FINITE CRYSTAL WITH A LINEAR LATTICE PERIOD VARIATION. By A.V.Kolpakov and V.I.Punegov, Department of Physics, Moscow State University, Moscow, USSR.

In (*) (Chukhovskii F.N. et al. Acta Cryst., 1978, A34, 610) a dynamical theory of X-ray diffraction in a semi-infinite crystal with a constant deformation gradient has been presented. A kinematical theory for thin crystals with a linear onedimentional lattice constant variation has been developed in (**) (Kolpakov A.V. et al. Kristallografija, 1977, 22, 473). The present report discusses a dynamical diffraction in a crystal of finite thickness with a linear change in the interplanar spacing. For this case the amplitude of Bragg reflection R (the notations see in (*)) is:

$$R(z=0)=\frac{\pi\varkappa^g P e^{-i\frac{\pi}{4}}}{|\gamma^g|\lambda(4B)^{\frac{1}{2}}}\,\frac{D_{-\nu-1}(-x_1)D_{-\nu-1}(x_0)-D_{-\nu-1}(x_1)D_{-\nu-1}(-x_0)}{D_{-\nu-1}(-x_1)D_{-\nu}(x_0)+D_{-\nu-1}(x_1)D_{-\nu}(-x_0)}$$

where D_j - Weber`s function of the j-th order

The results for a thin or semi-infinit crystal follow from this general solution. We interpret the results by analogy with Fresnel construction (**). In particular, it is shown, that the diffraction in finite and semi-infinite crystal with linear lattice period variation to be similar to Fresnel diffraction at the slit and screen edge, respectively. The intensity maxima of the one-sided oscillation profile of the reflection curve for a semi-infinite crystal correspond to the Bragg conditions for odd Fresnel layers in the crystal. For the practical purposes we have been developed a good convergent approximation.

11.7–1 DIFFRACTION OF THERMALLY SCATTERED X-RAYS IN CRYSTALS. By Y. Kashiwase and Y. Kainuma, College of General Education, Nagoya University, Chikusa-ku, Nagoya 464, Japan.

The aim of this paper is to review our recent experimental studies on the diffraction pattern formed by the thermal diffuse scattering (TDS) reflected secondarily by the net planes in a crystal which has been predicted theoretically by one of the present authors (Kainuma,J. phys. Soc.(1961)16,228). The patterns were observed in the Bragg arrangement by the present authors on the Laue photograph of a urea nitrate crystal (Kashiwase,Kainuma and Minoura, J.Phys.Soc. Jpn.(1981)50,2793) and pyrolytic graphite crystals (Kashiwase,Kainuma and Minoura, Jpn.J. Appl.Phys. (1982)21,L34. Acta Cryst.(1982)A38, 390). The patterns consisted of a defect line across the 002 diffuse spot and an excess line across the diffuse background around the incident beam spot. On the other hand, an excess line in place of defect line was found across the 200 diffuse spot on Laue photograph of a calcite crystal in the Bragg arrangement (Kashiwase and Kainuma, J.Phys.Soc.Jpn. (1982) 51,2379). Strong excess lines were also observed across the 111 diffuse spot in the Bragg arrangement and across the 220 diffuse spot in the Laue arrangement on Laue a photograph of a germanium crystal (Kashiwase and Kainuma, delivered at the Meeting of the Phys.Soc.Jpn. held at Yokohama National University (1982) to be published). The crystals given above are classified into two groups. The former crystals are relatively imperfect. TDS related to the defect line is very strong owing to their remarkable softness. X-ray absorption coefficients are small. The latter crystals, however, are ideally perfect. X-ray absorption coefficients are very large. TDS related to the excess line is relatively strong. The excess line across the diffuse scattering can be explained by the anomalous transmission of the TDS.

11.7–2 SIMULATION OF X-RAY TRAVERSE TOPOGRAPHS

by Y. Epelboin and A. Soyer, Laboratoire de Minéralogie-Cristallographie, associé au CNRS, Université P.et M. Curie, Paris, France

The two main difficulties, to simulate the image of a defect, in a traverse topograph, are the required precision of the numerical algorithm and the time needed to integrate the Takagi-Taupin equations. The precision of varying step algorithms permits now such a calculation. However, we have found that the reciprocity theorem could not be applied to this computation because the accuracy of the algorithm is still insufficient.

Comparisons of computed profiles of intensity through the image of a dislocation with the corresponding experiment show that the simulation of the real experiment i.e. the addition of individual section topographs gives simulated images of good quality.

Since the time of computation would be too long, also when using giant computers, we wrote the program in assembler language for an array processor linked to a local small machine. The performances are very good and it has been possible to simulate images of dislocation in a reasonnable time.

We have studied the influence of the Burgers vector on the contrast of dislocations and shown that it is often possible to determine both its sense and magnitude.

Our study of packets of dislocations perpendicular to the faces of a lithium formate crystal show that the image predicted by simulation of traverse topographs is quite different from the one when using the kinematical approach. It suggests that for such an orientation and for such large deformations, the image could be predicted using the criterion of the geometrical optics.

Simulation of traverse topograph can now be used for defects characterization. It might be a first approach to understand the contrast of Laue images in synchrotron experiments.

11.7–3 CIRCULAR POLARIZATION OF X-RAYS VIA BRAGG SCATTERING. By Boris W. Batterman, Fritz-Haber-Institut der Max-Planck-Gesellschaft, D-1000 Berlin 33; and Cornell High Energy Synchrotron Source (CHESS), Cornell University, Ithaca, New York, USA.

In Bragg reflection from perfect crystals, dynamical theory predicts a 180° phase shift as the Darwin curve is traversed in angle-space. Indirect experimental verification of this is the motion of standing waves (Batterman, Phys. Rev. (1964) 133, A759) as an incident wave scans the range of total reflection. By combining σ and π polarization curves, relative phase shifts as large as 50° should be achievable experimentally. Experiments in progress will attempt to confirm that a phase shift of 90° (i.e., circular polarization) can be obtained. The device is the X-ray analogue of the optical Fresnel rhomb.

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11.7–4 MEASUREMENT OF THE EFFECTIVE MASS ENHANCEMENT OF THE DEFLECTION OF NEUTRONS IN PERFECT CRYSTALS. By A. Zeilinger, C. G. Shull and M. A. Horne, Department of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139 and S. A. Werner, Department of Physics, University of Missouri, Columbia, MO 65201 USA.

Theory predicts that neutrons propagating inside a crystal under dynamical diffraction conditions will suffer highly enhanced deflections if subject to an external force. This phenomenon is due to the large curvature of the dispersion surfaces in the vicinity of the Laue point. By analogy to the case of electrons in solids, this behavior may be interpreted as being due to an effective mass of neutrons in crystals. This effective mass is of tensor character and of positive or negative sign. Its magnitude varies with neutron propagation direction and it is smallest for neutrons propagating along the lattice planes while for neutrons propagating along the edges of the Borrmann triangle the effective mass approaches the free-space mass of the neutron.

In the experiment, neutrons of λ=2.464Å were defined by a crystal collimator such that only neutrons within $\pm 9.4 \times 10^{-8}$ radians of the chosen Bragg-angle, were passed through the system. The propagation of these neutrons in a 52.1mm thick Si-crystal set at the exact Bragg condition in Laue transmission was then studied. Without a magnetic field these neutrons were found to propagate along the (220) lattice planes as expected. A magnetic field with a gradient oriented normal to the lattice planes was then turned on in order to provide a force acting on the neutrons while propagating inside the crystal. The resulting beam deflections were found to be larger by a factor of 2.1×10^5 than those expected in the same field gradients in vacuum. This is in agreement with theoretical prediction based on the effective mass model. Using slightly off-Bragg neutrons and studying the polarization of the resulting beams, the sign of the effective mass was experimentally determined. Again in agreement with expectation it was found that the effective mass of β wave field