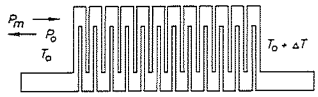
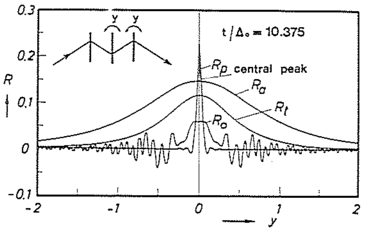
11.7–23 MULTIPLATE LAUE- AND BRAGG DIFFRACTION: INTENSITY PROFILES AND COHERENCE PHENOMENA. By D. Petrascheck, H. Rauch and E. Seidl, Universität Linz and Atominstitut der Österreichischen Universitäten, Wien, Austria.

The total reflection width of a monolithic meander silicon crystal (figure) can be increased by a proper temperature gradient, as tested by thermal neutron diffraction. Although the related intensity profiles are easily calculated the wave functions become very complicated. A meander crystal with a temperature gradient may be a valuable tool for neutron backscattering spectrometers.

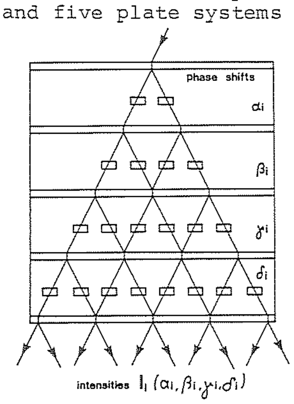


Multiple Laue-rocking curves for neutrons show due to their weak absorption, a very narrow central peak, whose angular width is in the order of the ratio of the lattice constant to the thickness of the crystal plate (d_{hkl}/t). It can easily be observed by using a monolithic designed multiplate system (Bonse et al., Phys. Lett. (1979) 420; Rauch et al., Z. Physik (1983) 51B, 11). Recently we have calculated the related rocking curves analytically, using the two wave field approximation of dynamical diffraction theory (Petrascheck and Rauch, Acta Cryst. (1984) in print). Various contributions to triple Laue-rocking curves are shown in the figure. The narrow central peak is described by the formula



$$R_p \simeq \frac{3\pi}{16}\left[2\,\frac{J_2(2Ay)}{(2Ay)^2}+\frac{J_2(4Ay)}{(4Ay)^2}\right]$$

which has only a weak dependence on the crystal thickness and on the wave length spread of the beam. This penomenon can be useful for high resolution small angle diffraction experiments on macroscopic objects. Neutron interferometry with two and three plate systems became a valuable new tool of neutron optics in the past (Bonse and Rauch, eds., Neutron Interferometry, Clarendon Press 1979). We have now calculated the intensities and the phase dependencies for four and five plate systems (see figure). The wave length spread of the beam and the associated loss of the interference contrast at high order has been included in these calculations. It is also shown how the phase information can be recovered by applying a proper phase shift between the following crystal plates. Such systems represent a generalization of phase echo systems (Badurek et al., Lect. Notes Phys. (1980) 128, 136).



11.7–24 INELASTIC SCATTERING OF NEUTRONS IN PERFECT CRYSTALS. By D. Petrascheck, Institut für Theoretische Physik, Universität Linz, A-4040 Linz, Austria

The interaction of neutrons with the nuclei of a crystal is decomposed into a part with lattice periodicity and a non-periodic part, which contains the dynamics of the nuclei. The first part is responsible for the coherent elastic scattering. The eigenstates of such a Hamiltonian are Bloch states, which are known from the dynamical theory of diffraction. The second part defines the interaction potential, which describes inelastic coherent and incoherent scattering of Bloch neutrons by phonons.

The interaction is treated in the first Born approximation in analogy to the usual neutron scattering theory. Coherent and incoherent cross sections are evaluated for the one and two beam cases for both Laue and Bragg geometry. Special attention is paid to the coherent one phonon scattering. The dynamic structure factor reads

$$S_c^{(1)}(\vec K,\vec K',\omega)=\sum_{\vec q,\lambda}\gamma(\omega(\vec q,\lambda))\left|\frac{1}{N}\sum_{i,j}\sum_{\vec G,\vec H}v_i^*(\vec G)\,w_j(\vec H)\,\Delta(\vec\kappa_{ij}-\vec q)\,e^{-W(\vec\kappa_{ij}+\vec G-\vec H)}\,(\vec\kappa_{ij}+\vec G-\vec H)\vec\varepsilon(\vec q,\lambda)\right|^2$$

$\gamma(\omega(\vec q,\lambda))$ contains the energy conservation for the thermal weighted phonon creation and annihilation processes. $v_i(\vec G)$ and $w_j(\vec H)$ are the amplitudes of the Bloch functions of the incoming and outcoming waves respectively. W is the usual Debye-Waller factor. $\Delta(\vec\kappa_{ij}-\vec q)$ describe the pseudomomentum conservation in thick crystals. In thin crystals $\Delta(\vec\kappa_{ij}-\vec q)$ give rise to oscillating terms, which vanish with increasing thickness.

In the Laue case the results are compared with the special case of T=0 and thin crystals treated by Mendiratta (Phys. Rev. (1976) B 14, 155). However the suggested observation of Pendellösung oscillations in the one phonon peak requires a narrow incident beam, otherwise the oscillations cancel out by integrating over the width of the incident beam.

As in the electron diffraction Kikuchi lines are expected to appear, if the incident beam is far from a Bragg condition. For the Bragg case the results could be compared with the geometrical aspects investigated recently by Wilkins (P.R.L. (1983) 50, 1862)).

The elastic incoherent scattering function

$$S_i^{(o)}(\vec K,\vec K',\omega)=\delta(\hbar\omega)\frac{1}{N}\sum_{\ell}\left|\sum_{i,j}\sum_{\vec G,\vec H}v_i^*(\vec G)\,w_j(\vec H)\,e^{-W(\vec\kappa_{ij}+\vec G-\vec H)}\,e^{-i\vec\kappa_{ij}\vec a_\ell}\right|^2$$

has now an additional structure in the vicinity of Bragg points. For special situations in Laue and Bragg cases an enhancement of the intensity is found.