possible to study the shape of the light pulses produced as a result of the mode self-capture in a semiconductor laser with an external mirror, and to determine the number of self-synchronized modes.

The realization of the self-synchronization of the majority of modes in a semiconductor laser will make it possible to obtain ultrashort pulses of coherent light of $\sim 10^{-12}$ sec duration and with a repetition frequency from 10^{11} to 10^{8} Hz.

In conclusion, the authors thank Yu. P. Zakharov and V. I. Molochev for preparing the diode and G. A. Shevelev for help with the work.

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* Self capture of modes is realized effectively when the resonator Q is modulated by an external force at a frequency close to the difference between the frequencies of the axial modes or with the aid of an additional nonlinearity, produced for example by saturable filters [6-8].

ANOMALOUS TRANSMISSION OF X-RAYS IN TIN SINGLE CRYSTALS

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When x-rays pass through perfect or near-perfect crystals at the Bragg angle to the crystallographic planes, the absorption coefficient for the transmitted beam becomes anomalously low.

This phenomenon, first observed by Borrmann in quartz single crystals [1] and investigated subsequently also in calcite, germanium, and silicon [2-5], served as the basis for the development of a new method of studying thermal vibrations in crystals, of determining the Debye temperature, and also to observe and control various types of disturbances to the

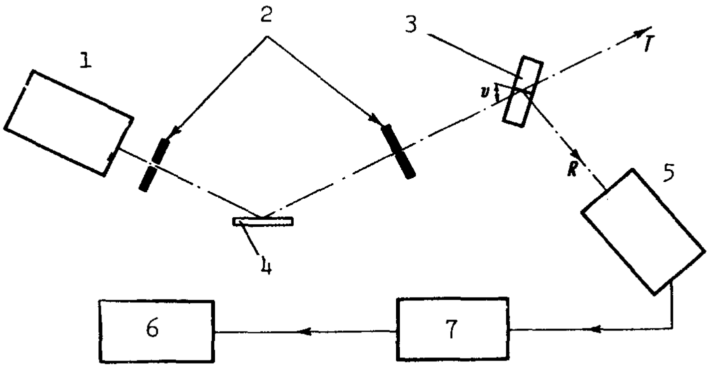

Fig. 1. Experimental setup: 1 - x-ray tube, 2 - diaphragms, 3 - investigated single crystal, 4 - monochromator - quartz [1011], 5 - scintillation counter, 6 - recording unit, 7 - pulse-height analyzer.

periodicity in crystal lattices [6-8].

It was proposed (e.g., [6]) that no anomalous transmission should take place in metallic crystals, since such crystals contain a large number of dislocations and other defects. The anomalous transmission observed in the diffraction of x-rays by the (0002) planes in thick zinc crystals was regarded as an exception and was attributed to singularities in the character and arrangement of the dislocations, which in this case did not exert any influence on the diffraction phenomena [6]. *

However, it was established experimentally that the connection between the number of dislocations and the anomalous absorption coefficient is not unique and depends on the material of the crystal [10].

We observed anomalous transmission of x-rays in KCl single crystals containing 6×10^3 - 10^4 dislocations per cm^2. The Borrmann effect in KCl crystals disappears at a dislocation density $\sim 10^5$ per cm^2 [11], whereas for germanium crystals the critical value of the dislocation density is $\sim 1.7 \times 10^6$ per cm^2 [8,12]. This is apparently connected with the character of the coupling in the lattice, and the requirements with respect to the degree of perfection required to be able to observe the anomalous transmission are less stringent for crystals whose electric and optical properties are less sensitive to structure defects. A noticeable difference in the dependence of the coefficient of anomalous transmission on the dislocation density was obtained in [10] even for crystals of the same type - Ge and GaAs.

In metals, the electron gas screens the existing lattice defects strongly, so that it might be assumed that the Borrmann effect cannot be observed in metallic crystals having a relatively large number of defects compared with crystals of other types.

We observed the anomalous transmission experimentally in one of the most "delicate" crystals - single crystals of tin, in the case of diffraction by the planes (020) and (220). In spite of the appreciable angular divergence of the beam (~40"), the effect is very sharply pronounced.

We used in the experiments a modernized x-ray setup of the URS-50IM type. (The experimental setup is shown in Fig. 1.) The reflecting-crystal positions were 1 and -1. We investigated the transmission of the characteristic x-radiation of molybdenum; a quartz monochromator separated the K_β line (19.6 keV). The beam transmitted through the tin single crystal (T) and the Laue-scattered beam (R) were registered with a scintillation counter provided with a recording attachment.

The tin single crystals were obtained by growing oriented single crystals in optically polished molds [13].**

Figure 2 shows the relative intensities of the scattered and transmitted MoK_β radiation in the case of Laue-diffraction from the (020) plane in single-crystal tin 0.6 mm thick and from the (220) plane at single-crystal thickness 0.4 mm. The experimental dependence of the transmitted-beam intensity on the angle of rotation of the investigated crystal bout the Bragg angle agrees well with the curves of the dynamic theory for the corresponding values of the parameter μt (μ - linear absorption coefficient, t - crystal thickness).

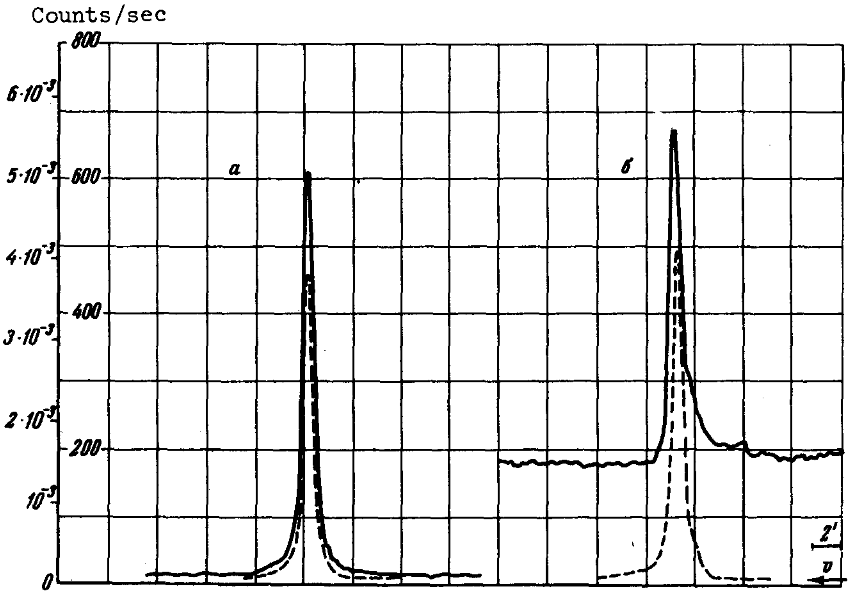

Fig. 2. Laue-diffraction of MoK_β x-radiation in tin: a - crystal thickness 0.6 mm, reflection planes (020), b - crystal thickness 0.4 mm, reflection planes (220). Solid curves - transmitted part of radiation, dashed - reflected part of radiation.

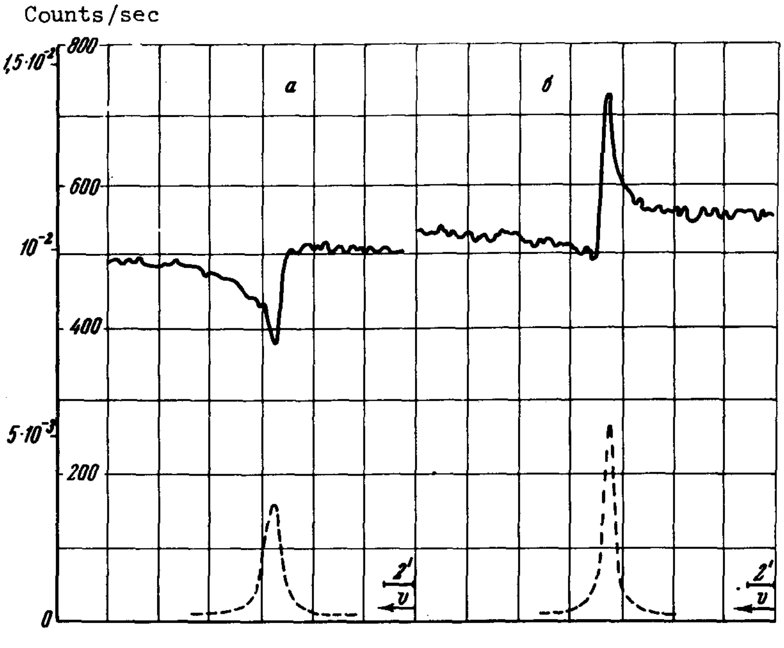

Fig. 3. Laue-diffraction of MoK_β x-radiation in KCl. Crystal thickness 2.5 mm, reflection planes (020), a and b - crystal sections with different degrees of perfection. Solid curves - transmitted part of radiation, dashed - reflected part of radiation.

The investigated tin single crystals are inhomogeneous with respect to the degree of perfection of the structure; the intensities and the half-widths of the diffraction peaks vary noticeably, depending on the section of the crystal on which the beam is incident. Topographic pictures by the method of Borrmann and Lang have shown that certain crystals have a cellular structure (individual cells surrounded by a dense dislocation grid), while others show more transparent regions with dislocation density $\gtrsim 10^6$.

An increase in the number of defects without a change in the crystal thickness has different effects on the anomalous transmission in the tin single crystals investigated by us and in KCl. In tin, with increasing number of defects, the form of the curve of the relative intensity of the transmitted beam remains unchanged, as manifest by the broadening of the diffraction peak, and only the absolute intensity of the anomalously transmitted radiation changes. An increase in the dislocation density in KCl crystals (causing a broadening of the diffraction peak) leads to an appreciable change in the character of the curve of relative intensity of the transmitted beam; in spite of the fixed thickness of the crystal, the peak of the anomalous transmission is even replaced by an extinction dip, and the "effective" value of μt decreases (Fig. 3). This effect is apparently connected with the difference in the character of the structure disturbances, or else is due to the type of coupling in the lattice.

The results confirm the hypothesis that the Borrmann effect can be observed in metallic crystals in the case of diffraction from different planes, and that for metals the requirements with respect to the degree of structure perfection are apparently much less stringent than for ionic crystals and for crystals with directed valence bonds between the atoms.

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* The Borrmann effect was observed also in diffraction of x-rays from the (111) planes of highly perfect copper crystals containing less than 10^3 dislocations per cm^2 [9].

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