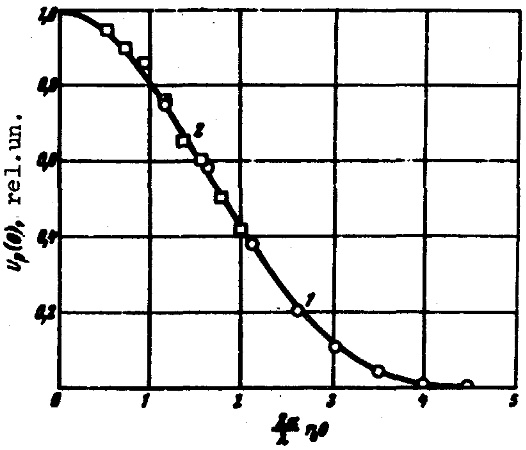

Fig. 2. Angular distribution of the strength of the scattered light $u_p(\theta)$: 1 - sounding light beam at a distance 0.5 mm from the illuminated surface of the sample, $r_0 = 7.6 \times 10^{-4}$ cm (light circles); 2 - sounding light 1 mm away, $r_0 = 3.4 \times 10^{-4}$ cm (light squares). Solid line - the function $G^2(r_0\theta)$.

An independent determination of r_0 was made also by comparing the experimental data on the angular distribution of the strength $u_p(\theta)$ of the scattered light with the theoretical formula (2). To this end, the strength of the light scattered at angles $\theta \pm \Delta\theta$ was plotted as a function of $(2\pi/\lambda)r_0\theta$ (Fig. 2), with $u_p(\theta)$ assumed proportional to the photoresistor response normalized to the area of the annular windows of disks 5. The parameter r_0 was chosen from the condition that the experimental points fit best the function $G^2(r_0\theta)$ characterizing the angular distribution is shown by the solid line in Fig. 2. It is seen from the figure that it is possible to choose values of r_0 such that good agreement is observed between experiment and calculation. At the first position of the sounding beam $r_0 = 7.6 \times 10^{-4}$, and at the second position $r_0 = 3.4 \times 10^{-4}$. These values of r_0 are in good agreement with the values determined from (5) for the same positions of the light probe. We note that when r_0 is determined from the angular distribution of the scattered light there is no need to know the carrier density in the condensed phase p_0 and the absorption cross section S. The obtained drop dimensions agree also with the value $r_0 \approx 10^{-3}$ cm determined at the same temperature and under analogous excitation in [5] from the absorption of submillimeter radiation of the condensed phase in germanium.

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SUPPRESSION OF (n,γ) REACTION IN RESONANT SCATTERING OF NEUTRONS BY A PERFECT CdS CRYSTAL

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It was shown in an earlier paper [1] that for neutrons whose energy is comparable with the excitation energy of the resonant level of Cd^{113} (0.178 eV), in accord with the predictions of the theory [2], the inelastic channels of the nuclear reactions are suppressed, i.e., if the Bragg conditions are satisfied a perfect absorbing crystal becomes anomalously transparent. This effect was observed both in the case of reflection and in the case of transmission, with the exception of the energy region immediately adjacent to the resonance, in which, owing to deterioration of the experimental conditions, it was possible to observe only anomalously strong reflection of neutrons. A detailed analysis shows that in experiments carried out in the resonant region it is necessary to take into account a number of factors that make the interpretation of the results more difficult.

First, almost all the low-lying resonant levels (including the Cd^{113} resonance) line in an energy region corresponding to short wavelengths ($\lambda < 1$ Å). Even the most stringent limitations on the nonmonochromaticity and divergence of the incident neutron beam ($\Delta\lambda/\lambda \sim 10^{-2}$, $\alpha \sim 10^{-3}$) admit, within the limits of the existing capabilities, the possibility of simultaneous reflection of the neutrons from many crystal planes. Since the reciprocal-lattice points corresponding to the additional reflections are situated exactly on the Ewald sphere, their influence can be taken into account in the kinematic approximation. Although such a problem has not yet been solved, it is obvious that the observed effect of the anomalous transmission should be smaller than that calculated theoretically for reflection from one crystal plane. This circumstance must be taken into account also in resonant scattering of γ quanta, although the situation here is simpler because of the high monochromaticity (but not divergence), of the beam. Second, the anomalous transmission may decrease because of insufficient perfection of the crystal. Finally, the latter circumstance is connected with the influence of "higher orders" of reflection. The neutron beam, after reflection from the monochromator, contains besides the fundamental wavelength (λ) also a set of so-called "higher orders" (λ/n, where n is the order of the reflection), for which the Bragg condition is satisfied simultaneously with the fundamental wavelength. Since the energies of the "higher orders" near the resonance are 4, 9, ..., n^2, ... times larger than E_{res}, the neutrons having these energies are weakly absorbed (the crystal is normally transparent for them). The fraction of "higher-order" neutrons in the reflected beam should increase in comparison with the incident one with increasing difference between the absorption cross section at resonance and at $4E_{res}$, $9E_{res}$, ..., n^2E_{res}, ... and with increasing crystal thickness, i.e., with increasing μt (μ is the normal absorption coefficient and t the crystal thickness). This means that observation of anomalously strong neutron reflection cannot be regarded as proof of the suppression of the inelastic channels in the resonant region of energies, if the fraction of the "higher orders" in the reflected beam is unknown. It is clear also that the most convincing proof of the existence of the effect of suppression is provided by transmission experiments. We have therefore searched for the suppression of the inelastic channels at resonant energies in transmission experiments.

The experimental procedure was in the main the same as in [1], except that perfect quartz single crystals were used in lieu of germanium crystals as the monochromator, because the interplanar distances of the reflection pair $(10\bar{1}1)$ SiO_2 and $(000\bar{2})$ CdS (3.33 and 3.35 Å, respectively), are smaller than for the pair $(\bar{1}\bar{1}\bar{1})$ Ge and $(000\bar{2})$ CdS, and the dispersion is therefore less in this case. The experimental widths of the reflection curves obtained with the quartz monochromator (16 - 19") turned out to be smaller than with the germanium one (40 - 42"), but still much larger than expected from the estimate of the dispersion (4.5"). The latter is apparently due to the imperfection of the SiO_2-CdS crystal pair. Indeed, when the CdS crystal was investigated with a two-crystal x-ray spectrometer (Mo K_α radiation, Ge(111) monochromator, Bren-Laue geometry, $\mu t = 12$), the width of the anomalous transmission and Laue-reflection curves (11 - 12") exceeded somewhat the calculated value for an ideal crystal (8 - 9"). To decrease the influence of the "higher orders," thinner samples were used (t = 0.37 mm). In addition, we used single-crystal quartz filters cooled to 80°K, and took measures to reduce the fast-neutron background. The fast-

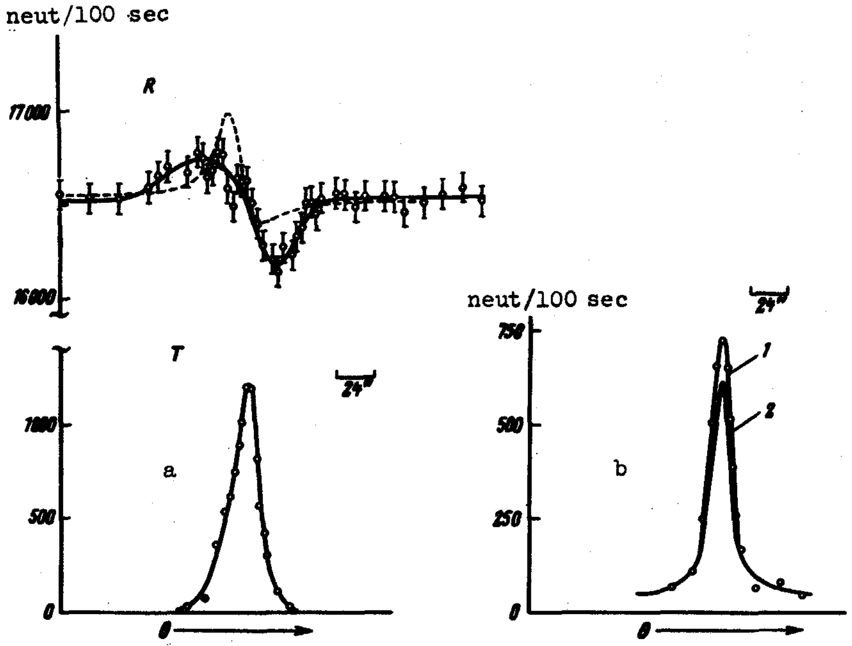

Fig. 1. Reflection (R) and transmission (T) curves for λ = 0.81 Å (E = 0.123 eV): a - t = 0.37 mm (μt = 2.81), obtained with quartz filter 100 mm thick; b - t = 0.96 mm (μt = 7.35), obtained without filter; curve 1 - total reflection intensity, curve 2 - total contribution of "higher orders."

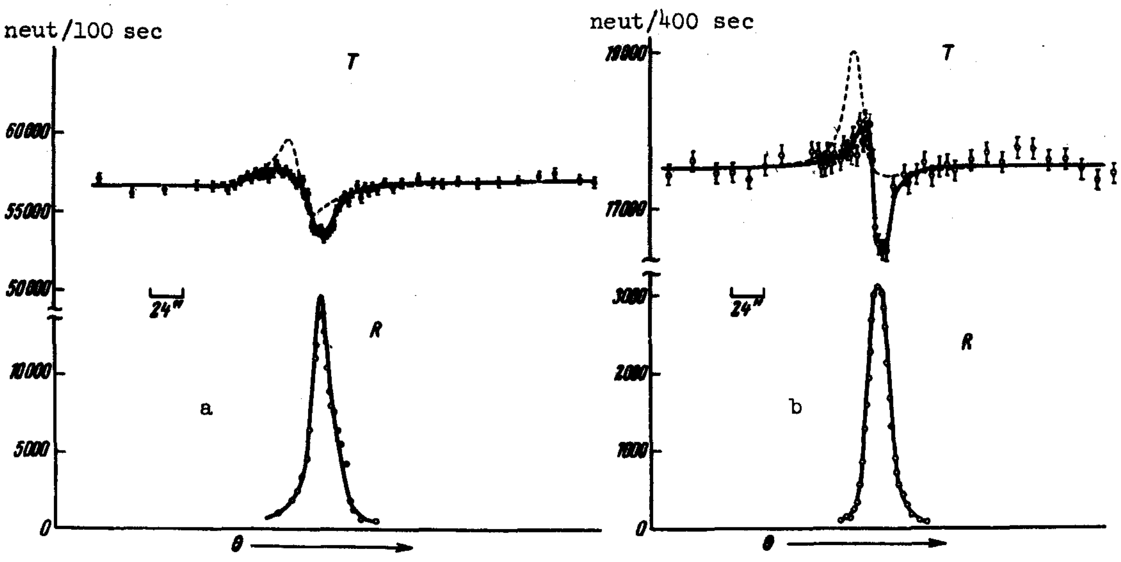

Fig. 2. Reflection (R) and transmission (T) curves for λ = 1.06 Å (E = 0.08 eV); obtained with quartz filter 100 mm thick: a - t = 0.37 mm (μt = 1.92), b - t = 0.96 mm (μt = 4.99).

neutron fractions in the incident, transmitted, and scattered beams were determined by the cadmium-foil method [3].

Figures 1 and 2 show the measurement results, which indicate that all the transmission curves (T) have the dispersion form characteristic of crystals of intermediate thickness ($1 < \mu t < 10$). Such a character of the transmission curve is due to the interference between the two wave fields in the crystal ("incident" and "reflected") and constitutes direct experimental proof of the existence of suppression of the inelastic channels in resonant scattering of the neutrons. The measurements were repeated many times, and in all cases the value of the maximum on the T curves greatly exceeded the experimental error, and the fraction of the "higher-order" neutrons in the anomalously transmitted beam did not exceed 1 - 2% (using quartz filters). At $\lambda = 1.06$ Å (Fig. 2), the singularities on the T-curves become more sharply pronounced with increasing μt, but then the requirements concerning the measurement accuracy become more stringent, and the fraction of the "higher orders" in the scattered beam increases (from 10 to 20% without the quartz filters). At large $\mu t \approx 7.35$ ($\lambda = 0.81$ Å, t = 0.96 mm) the scattered beam, as seen from Fig. 1b, is due almost entirely to the "higher-order" neutrons, and observation of the anomalous transmission is difficult under these conditions.

The theoretical curves (dashed lines in Figs. 1 and 2) were obtained by convolution of the R-curve, the shape of which is governed by "instrumental" factors, with the T-curve calculated from the formulas of [2]. We used the characteristic temperature $\theta = 214$°K [4] to calculate the Debye-Waller factor of the Cd atoms, and the Debye-Waller factor for the sulfur atoms was assumed equal to unity, since it exerts little influence on the form of the theoretical T-curve. Although the theoretical curves describes qualitatively the experimental data, there are nevertheless appreciable differences, due either to the insufficient perfection of the CdS crystal or to the influence of "many-wave" processes. The latter is not very probable, since a difference of the same type was observed also at $\lambda = 2.5$ Å, where no simultaneous reflection from other crystal planes took place.

The results show thus that in resonant scattering of particles (neutrons), just as in the case of waves (γ rays), the anomalous-transmission effect remains in force, i.e., the (n,γ) reaction is suppressed when a neutron interacts with a perfect crystal in the Bragg position.

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TWO-STEP SELECTIVE PHOTOIONIZATION OF RUBIDIUM ATOMS BY LASER RADIATION

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1. We report here the first experiment on selective two-step photoionization of atoms (Rb) by radiation from two lasers operating at different frequencies. In the two-step photoionization scheme, the radiation of the first laser transfers the atoms (in this experiment, Rb atoms) from the ground to the excited state. The atoms are simultaneously illuminated by light from the