The suppression coefficients, which are usually determined from the measured cross section to that calculated without allowance for the distortions, are $k_p = 0.47$ and $k_s = 0.30$. As seen from the table, our data for the Li^7 p-shell differ from those cited by the Japanese group [7], but are close to the data of the (p, 2p) experiment [5]. The difference in the s-shell parameters is much less.

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INTERFERENCE STATES OF OPTICAL EXCITONS. OBSERVATION OF ADDITIONAL WAVES

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We consider size quantization of optical excitons in ultrathin crystals. It becomes manifest in a special structure of the optical spectrum of the exciton. We observed the interference between the additional waves, which was predicted by Brodin and Pekar [1].

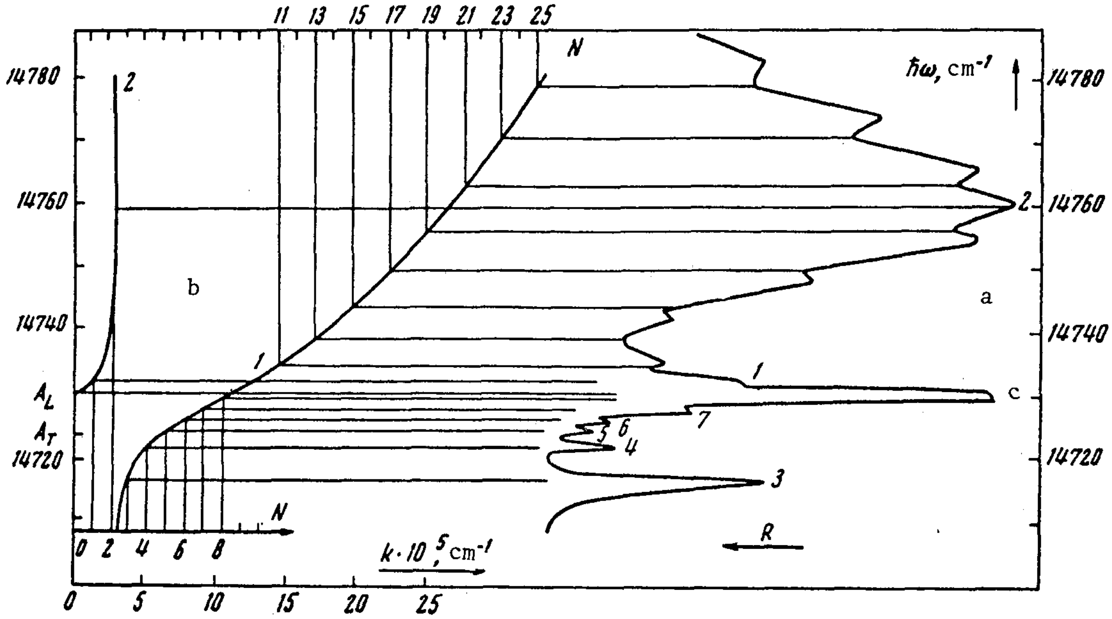
In thin crystals of thickness $\ell \lesssim 0.5\ \lambda$ (where λ is the wavelength of the light in the transparency region), size quanitzation of the optical-exciton states takes place in a direction perpendicular to the plane of the crystal, and these states should form a discrete set of two-dimensional subbands in the plane of the sample. The quantization is due to interference between the optical-exciton wave when it is multiply reflected between the front and rear faces of the crystal. Such interference states should become manifest in the optical spectrum of the exciton in the form of a definite interference pattern consisting of a finite number of lines passing through the entire resonance region of the spectrum. As a result, unlike ordinary interference of light observed in thicker crystals, it becomes possible to study the refractive-index singularities due to the optical-exciton interaction and spatial dispersion [2]. No such investigations can be performed in thick samples, owing to the crowding together of the interference pattern and to the strong-absorption of light in the resonance region.

We have investigated experimentally the interference states of optical excitons by determining the absorption, luminescence, and reflection spectra of CdS and CdSe crystals from 0.1 to 0.3 μ thick. The temperature of the crystal was 4.2°K, and the spectra were photographed with a spectrograph having a dispersion 1.9 Å/mm.

Figure a shows the reflection spectrum of a thin CdSe crystal ($\ell = 0.24 \pm 0.03$ μ) in the region of the line A (n = 1) at 4.2°K and at a light polarization $E \perp C$. As seen from the figure, on the long-wave side of the longitudinal-exciton frequency $A_L = 14\ 730.8\ \text{cm}^{-1}$ there is a district set of narrow interference minima in a frequency interval $\sim 15\ \text{cm}^{-1}$. They were set in unique correspondence with interference numbers N from 3 to 8. The numbers N = 1 and 2 correspond to interference minima located on the short-wave side of the resonance (see the figure).

To determine the order of the interference of the indicated minima, we used the formula for the refractive indices of two optical-exciton wavelengths [3]

$$n_{1,2}^2 = \frac{1}{2}\left\{\left(\epsilon + \frac{2mc^2(\omega - \omega_T)}{\hbar\omega_T^2}\right) \pm \left[\left(\epsilon - \frac{2mc^2(\omega - \omega_T)}{\hbar\omega_T^2}\right)^2 + \frac{8mc^2\epsilon\omega_{LT}}{\hbar\omega_T^2}\right]^{1/2}\right\} \quad (1)$$



a) Microphotometric curve of reflection spectrum (R) of a thin CdSe crystal in the region of the exciton line A (n = 1), E ⊥ C, T = 4.2°K. Crystal thickness ℓ = 0.24 μ. b) Dispersion curves of optical excitons (1, 2), determined from the experimental frequencies and from the obtained values of the interference order N.

where ε = 9.7 is the background dielectric constant of CdSe, $m = 0.58m_0$ is the effective mass of the exciton [4], $\hbar\omega_T = 14\,723.5 \pm 0.2$ cm^{-1} is the energy of the transverse exciton, and $\hbar\omega_{LT} = 7.3 \pm 0.5$ cm^{-1} is the energy of the longitudinal-transverse splitting. The last two parameters were determined in the course of the calculation. We substituted in this formula the experimental frequencies of the reflection minima and obtained the corresponding refractive indices.

The calculated refractive indices were substituted in the simplest interference condition for one wave without allowance for damping

$$k\ell = \frac{\omega_T}{c} n\ell = \pi N. \tag{2}$$

The error in the determination of N by means of this formula was not less than 10% of the integer values of N. Such an error is due to the fact that formula (2) does not take into account the damping and the presence of not one but two optical excitons. It is also possible that the published data on m and ε are not accurate enough. A more exact interference condition will be used in a more detailed article.

Another type of interference is observed on the short-wave side of the resonance, in the frequency range 14 735 – 14 780 cm^{-1}. The period of this interference is much larger than that of the first, and the amplitude is much smaller. The energy positions of these maxima likewise satisfy Eqs. (1) and (2) for the refractive index n_1 (+ sign in formula (1)) and for N running through odd values from 11 to 25. These singularities make the second interference much different from the first, which results from the reflection of one wave from two boundaries. Calculation shows that the observed short-wave reflection spectrum is the result of mutual interference of two optical-exciton waves 1 and 2 (Fig. b) as they pass through the crystal.

Knowing the numbers of the interference singularities and their frequencies, we can easily plot the dispersion branches of the optical excitons. Such plots are shown in Figs. a and b for CdSe.

A similar interference structure is obseqved also in the transmission and emission spectra of CdSe crystals. In transmission one sees the lines N = 3 – 6, and also the maxima connected with the interference of the additional waves. The latter alternate with somewhat larger intervals than the reflection maxima. This effect is due to absorption of one of the two waves in the crystal, namely the wave corresponding to the exciton propagation. Lines with N = 3 - 8 are observed in the emission spectra.

Analogous singularities in the reflection, transmission, and emission spectra were observed by us also in thin CdS crystals near the resonances A (n = 1), B (n = 1), and A (n = 2).

Thus, investigation of interference phenomena in ultrathin crystals reveal the size quantization of optical-exciton states and the additional waves. This makes it possible to trace the dispersion of the refractive index with allowance for the optical-exciton interaction and spatial dispersion.

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FEASIBILITY OF A SUPERSENSITIVE LASER METER FOR ARTIFICIAL ANISOTROPY AND FARADAY ROTATION OF THE PLANE OF POLARIZATION

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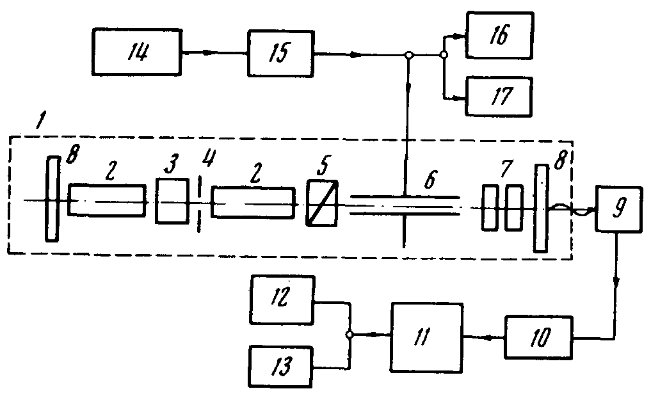
It is shown that the use of single-frequency solid-state laser of stable frequency and stable emission power make possible measurements of an induced anisotropy up to (10^{-10} - 10^{-11}) and of optical activity up to 10^{-6} - 10^{-7} second of angle.



Experimental setup for the measurement of the anisotropy induced in air by an electric field: 1 – YAG:Nd$^+$ laser, 2 – active rods, 3 – 90° polarization rotator, 4 – diaphragm, 5 – polarizer, 6 – air capacitor, 7 – phase plate with adjustable anisotropy, 8 – resonator mirrors, 9 – photodiode, 10 – bandpass filter, 11 – measuring amplifier, 12,13,16,17 – instruments for monitoring the waveform and level of the signal, 14 – sound generator, 15 – power amplifier.

An investigation of the emission kinetics of high-stability solid-state lasers has shown [1, 2] that such lasers have high sensitivity to resonator-loss modulation at the frequency ω_r of the relaxation oscillations. The radiation-modulation coefficient m_r can be determined in this case by solving the nonstationary rate equations, and at small perturbations of the single-mode generation in a four-level system we have

$$m_r = \frac{\Delta\sigma c \tau}{2 L_r n} \qquad (1)$$

where $\Delta\sigma$ is the amplitude of the resonator-loss modulation per double pass, c is the speed of light, L_r is the optical length of the resonator, n is the excess of pump over threshold, and τ is the lifetime of the excited level.

This feature can be used, in particular, to measure very small values of artificial anisotropy and Faraday rotation of the polarization plane. On the other hand, it becomes possible to measure the optical constants that characterize these phenomena.