The measured wave velocities and sections of the hole surface are shown in the figure. At the employed directions of $\vec{k}$ and $\vec{H}$, the wave spectrum is determined by the holes (the contribution of the electrons to k is $\sim$1.5%), so that the interpretation of the results is facilitated because only one term remains in (3).

According to the figure, the wave velocity at both frequencies, with allowance for the correction for the temporal and spatial dispersion ($\sim$0.1% in strong fields) coincides in the entire investigated region with the experimental accuracy $\sim$0.1%. This yields the estimate $\Delta N/N < 0.1\%$.

It can be easily seen from (2) and (3) that the differences between the positions of the points in the figure for the cross sections and the values of the wave vectors in the assumed coordinate system reflect the m(H) dependence and the change in the anisotropy of the Fermi surface. These effects can be separated in principle by studying the anisotropy of the wave velocity. No such study was made so far, and we can only estimate here the change in mass. According to the figure, when S is changed by $\sim$20% the mass changes by only $\sim$1 - 2%, i.e., slower by one order of magnitude.

Thus, in the investigated range of fields, according to (4), the relative shift of the Fermi level coincides within $\sim$1% with the change of the extremal section, as shown in the figure.

Comparing the rates of change of m(H) and S(H), we can estimate the ratio of the hole Fermi energy E_F to the energy gap E_g within the framework of the two-band model. We get $E_F/E_g < 0.05$.

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ANOMALOUS SHIFT OF LUMINESCENCE BAND IN CERTAIN SEMICONDUCTORS

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A 0.1 - 0.2 eV shift of the luminescence band to the short-wave region of the spectrum, in a direction opposite to the shift due to increasing the temperature, is observed in $CdIn_2S_4$ and $AgIn_5S_8$ crystals with increasing intensity of the exciting light. The possible mechanisms of the phenomenon are discussed.

We have investigated the luminescence of the compounds $CdIn_2S_4$ and $AgIn_5S_8$ by exciting in single crystals of these compounds with avrious light sources: 1) a helium-neon laser of wavelength $\lambda_{exc} = 633$ nm, non-equilibrium carrier density generated by the light $\Delta n \simeq 10^{13}$ cm^{-3}, and 2) the second harmonic of a neodymium-glass laser, $\lambda_{exc} = 530$ nm, $\Delta n = 10^{17} - 5\times10^{19}$ cm^{-3}.

The crystals were mounted on a cold finger of a cryostat with adjustable temperature. The absence of noticeable heating of the samples when illuminated with pulses of the second harmonic of the neodymium-glass laser was confirmed by the behavior of the luminescence spectra, which shifted with increasing light intensity in a direction opposite to that of the temperature shift. The luminescence spectra excited by the light pulses were registered with the aid of an MDR-2 monochromator (inverse linear dispersion 4 nm/mm, resolution $\sim$5 Å), an FEU-84M photomultiplier, and a oscilloscope with memory. A selective U2-4 amplifier was used to register the luminescence excited by helium-neon laser light modulated at a frequency 1 kHz.

The compounds $CdIn_2S_4$ and $AgIn_5S_8$ belong to a large class of ternary semiconductors that contain intrinsic structure defects. One such defect, a vacancy in a tetrahedral environment of S atoms, when in a non-stoichiometric ratio in $CdIn_2S_4$, is a luminescence center whose ex-

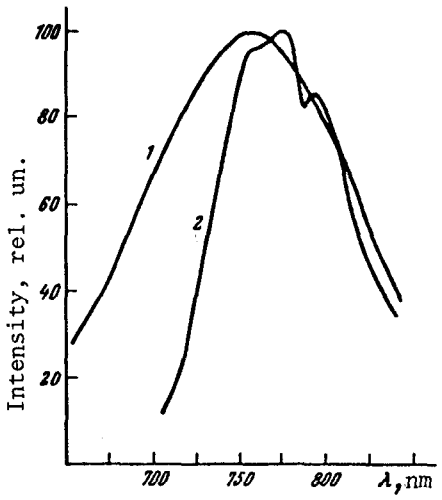

Fig. 1. Luminescence spectra of $CdIn_2S_4$ and $AgIn_5S_8$ (80°K): 1 - $CdIn_2S_4$ [1], 2 - $AgIn_5S_8$ (excitation with He-Ne laser light with photon flux density $\bar{n} = 3\times10^8$ cm^{-3}.

citation by light leads to emission with a maximum at 750 nm (80°K) and a half-width 0.3 - 0.4 eV [1]. Ours was the first study of the luminescence spectrum of $AgIn_5S_8$, which has the same type of luminescence centers and spectrum shape as $CdIn_2S_4$ (the position of the maximum of the band differs insignificantly, see Fig. 1.).

Figure 2 shows the luminescence spectra of $CdIn_2S_4$ and $AgIn_5S_8$ (77.3 and 300°K) obtained following excitation by light from the two mentioned sources, whose intensities were varied over a wide range. We note that at $\lambda_{exc} = 633$ nm (He-Ne laser) the local centers in $CdIn_2S_4$ were excited directly (absorption coefficient K = 2.5 cm^{-1} [2]), while at $\lambda_{exc} = 530$ nm (second harmonic of Nd laser) the excitation was via a forbidden band (K = 70 cm^{-1}, 77.3°K and K ≈ 500 cm^{-1}, 300°K [2]). Figure 3 shows plots of the positions of the luminescence maximum against the intensity of the exciting light and the temperature.

We note that in our experiments the shape of the luminescence spectra was practically independent of the excitation method (continuous excitation with 633-nm light, pulsed excitation with 530-nm light) and the excitation intensity, but the intensity of the luminescence excited by the second harmonic of a neodymium laser was larger by several orders of magnitude than when the helium-neon laser was used.

As seen from Figs. 2 and 3, the luminescence band, as a function of the intensity of the exciting light, shifts smoothly and quite appreciably (in the 750 - 680 nm interval) towards

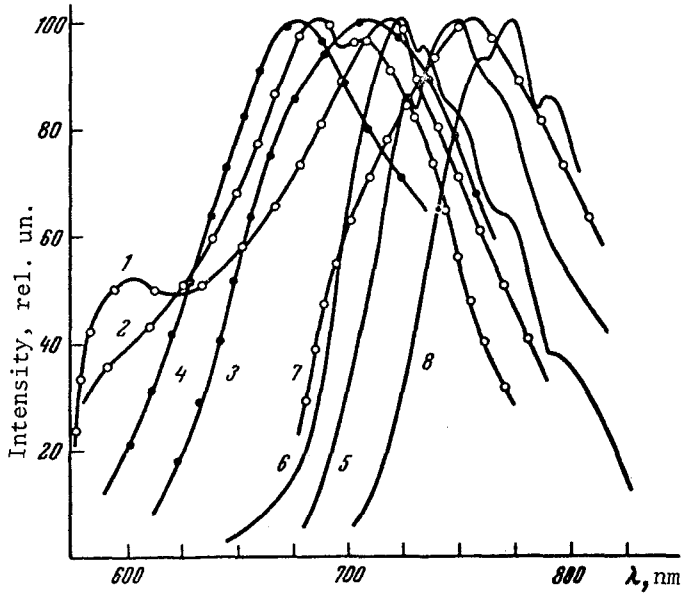

Fig. 2. Luminescence spectra of $CdIn_2S_4$ (1, 2, 3, 4) and $AgIn_5S_8$ (5, 6), excited by Nd-laser second harmonic: 1, 2 - 77.3°K, photon flux density $\bar{n} = 9\times10^{14}$ and 5×10^{15} cm^{-3} ; 3, 4 - 300°K, $\bar{n} = 8\times10^{14}$ and 3×10^{15} cm^{-3}; 5 - 77.3°K, $n = 6\times10^{14}$ cm^{-3}; 6 - 77.3°K, $\bar{n} = 6\times10^{15}$ cm^{-3} . 7, 8 - $CdIn_2S_4$ and $AgIn_5S_8$ (77.3°K), He-Ne laser excitation, $\bar{n} = 10^8$ cm^{-3}.

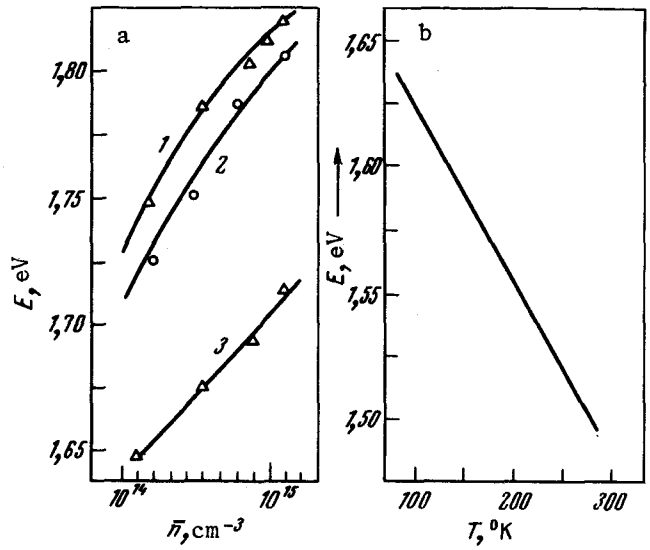

Fig. 3. Position of luminescence maximum vs exciting-light intensity (a) and temperature (b): a - 1) $CdIn_2S_4$ (300°K), 2) $CdIn_2S_4$ (77.3°K), 3) $AgIn_5S_8$ (77.3°K). b - $CdIn_2S_4$ [1]; excitation with xenon-lamp light; λ_{exc} = 400 - 500 nm.

the short-wave region of the spectrum, or in a direction opposite to the shift that occurs when the temperature is raised.

We know of no experiments on observation of giant (above several hundredths of an electron-volt) smooth shifts of the luminescence spectrum of a semiconductor towards the short-wave side; nor do we know the reason for such a shift. In our case the shift reaches 0.2 eV at 77.3°K and ∿0.3 eV at 300°K. The data shown in Fig. 3 offer evidence that the observed effect cannot be attributed to heating of the sample.

In our opinion, the possible causes of the observed effect can be: 1) a change in the elastic constants of the lattice; 2) generation of non-equilibrium phonons and their participation in the optical transitions, 3) collective effects in a high-density system of luminescence centers.

We note that concrete calculations entail certain difficulties, since they must be based on detailed information concerning the structure of the luminescence centers; no such information is available at present.

The observed effect can find very interesting practical applications; one of them is the development of light sources whose emission band can be varied continuously.

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BIEXCITON LUMINESCENCE POLARIZATION IN UNIAXIALLY DEFORMED GERMANIUM

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Strong linear polarization of the 0.709-eV emission line of germanium was observed under weak uniaxial deformation. This confirms that this line is due to biexcitons.

Experimental investigations of the properties of excitons when their density in germanium or silicon is high have shown that at relatively low densities the exciton system is a gas of exciton molecules, which condenses into a liquid phase at sufficiently high excitation levels [1]. There is, however, another point of view, according to which no biexcitons can be produced in these semiconductors, and the emission line ascribed to biexcitons ($h\nu$ = 0.709 eV in Ge and 1.08 eV in Si) actually belongs to the electron-hole condensate that exists even at very low