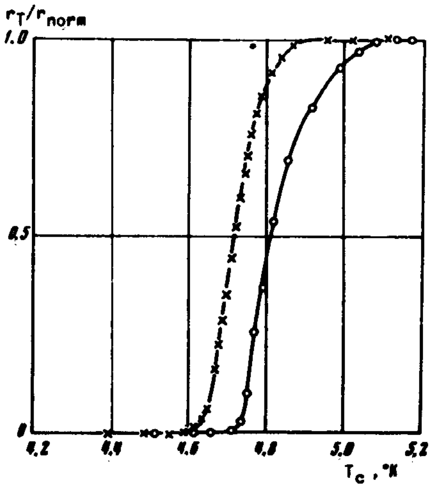

Superconducting transitions of GaAs at different pressures: 1 - p ≈ 300 kbar, 2 - 300 kbar.

in the inverval 260 - 300 kbar, at an average rate $dT_c/dp = 0.2 \times 10^{-5}$ deg/bar.

It was suggested in [4] that T_c of the metallic modifications of III - V compounds should be close to T_c of the isostructural or metallic modifications of IV elements, which have an atomic mass close to the "average" mass of the atoms of the compound. However, the transition temperatures of AlSb II (2.8°K at p = 120 kbar) and Ge II (5.35°K at p = 115 kbar), which have close atomic masses, differed strongly. Apparently such a comparison is meaningful only for compounds in which the atomic weights of the elements differ little from one another. Indeed, the obtained value T_c = 4.8°K for the metallic modification of GaAs in quite close to T_c of Ge II.

We take the opportunity to thank V.I. Verintsev, A.V. Kolchin, V.F. Malikov, and E.V. Funtikov for supplying the anvils of superhard material type SV.

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NARROW MOLECULAR RESONANCES UPON SATURATION OF ABSORPTION IN SEPARATED LIGHT BEAMS

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1. We report in this article the first observation of narrow molecular resonances within the Doppler line upon saturation of absorption in the field of two parallel spatially separated light waves. This effect is of considerable interest for the investigation of small-angle molecule scattering, the investigation of coherent interaction of molecules with a light field, and stabilization of the frequency of gas lasers.

2. Upon saturation of absorption on the Doppler-broadened transition of a coherent traveling wave, a "hole" is burned in the contour because of the saturation of the absorption of the molecules that are at resonance with the field, i.e., they have a definite projection of the velocity $\vec{v}$ on the direction of propagation of the wave $\vec{k}$:

$$|\omega_0 - \nu - \mathbf{kv}| \lesssim \Gamma << \Delta\omega_{\text{доп}}, \quad (1)$$

where ω_0, Γ, and $\Delta\omega_{Dop}$ is the frequency of the center, the homogeneous width,

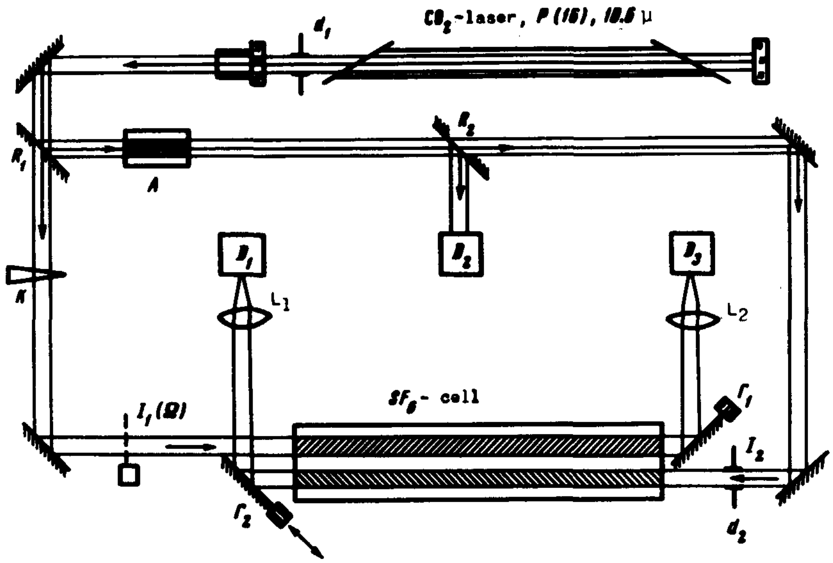

Fig. 1. Diagram of experimental setup: d_1, d_2 - diaphragm; R_1, R_2 - semitransparent mirrors, A - attenuator, c - calibrated plate, 0 - mechanical chopper, r_1, r_2 - total-reflection plates, L_1, L_2 - lenses, D_1, D_2, D_3 - Ge:Au detectors.

and the total width of the Doppler line, and ν is the frequency of the wave. In the case of a large lifetime, the excited molecules can propagate in the space around the beam. The collisions between molecules change the direction of the molecule velocity and the "hole" in the velocity distribution of the molecules "dissolves" quite rapidly. In order for the hole to "dissolve," even weak collisions with scattering of the molecules through small angles $\Gamma/\Delta\omega_{Dop}$ are important. However, if the gas pressure is sufficiently low and the molecule mean free path comparable with the diameter of the beam, then the "hole" is transported in space through a considerable distance.

It is possible to observe the transport of the "hole" in space by means of a coherent test wave of the same frequency, propagating in the opposite direction. Such a wave interacts with the molecules whose velocity projection on the direction of the strong wave satisfies a different condition:

$$|\omega_0 - \nu + kv| \lesssim \Gamma. \tag{2}$$

If $|\omega_0 - \nu| \gtrsim \Gamma$, then there exist no molecules satisfying the conditions for simultaneous resonance with both waves. An exception is the frequency region $|\omega_0 - \nu| \lesssim \Gamma$. Therefore only on passing through the center of the Doppler line can the test wave interact with the molecules that are previously saturated by the opposing waves and have traveled from one beam to the other without collisions. At that instant, the absorption of the test wave decreases resonantly, i.e., a narrow dip appears in its absorption.

This effect was predicted in the early papers, where it was proposed to obtain narrow resonances by saturating the absorption of the long-lived transitions of the molecules [1]. A detailed theory of the effect of saturation of absorption in separated fields is presented in [2].

3. The experimental setup is shown in Fig. 1. A CO_2 laser with a sealed tube 60 cm long and 10 mm in diameter operated at a wavelength 10.6 μ (the P(16) line) in the single-mode regime. At the frequency of the P(16) line, SF_6 has the largest absorption (κ_0 = 1.3 $cm^{-1}Torr^{-1}$), making it possible to work at low pressures of SF_6, when the mean free path of the molecules is maximal.

A beam-splitting plate R_1 and a system of diaphragms guided the CO_2 laser radiation, in the form of two separated opposing traveling waves, to an

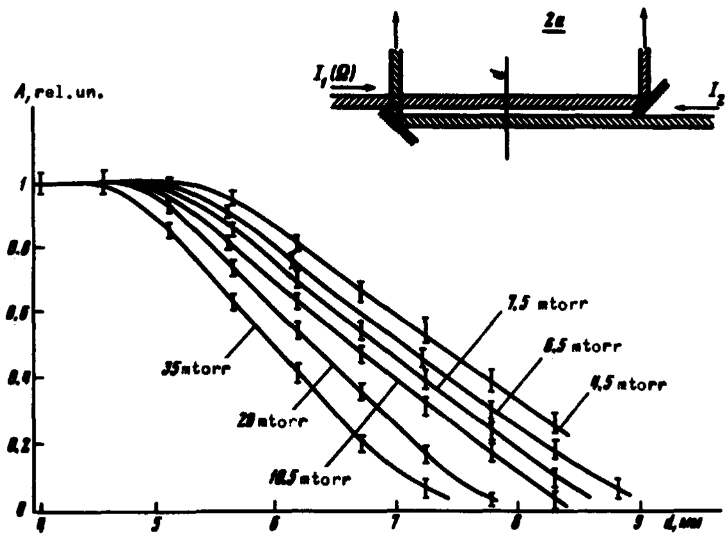

Fig. 2. Dependence of the reduced amplitude of the resonances on the ray-overlap parameter for different SF_6 pressures.

external SF_6 cell. The length of the absorption cell was L_{abs} = 120 cm, and the diameter was 36 mm. One of the two waves, $I_1(\Omega)$, saturated the absorption and its intensity was regulated by means of a calibrated plate c and modulated at a frequency Ω = 900 Hz. The intensity of the second wave I_2 was reduced by an attenuator in the form of a short cell filled with SF_6 at high pressure. A weak test beam passed through slit d_2 (width 4 mm) and after being reflected by the total-reflection rectangular plate r_2 it was registered by a Ge:Au detector. The detector signal was amplified by a narrow-band amplifier at the frequency ω and was fed after synchronous detection to an automatic recorder. The distance between the separated light beams was varied by parallel displacement of the plate r_2, which smoothly overlapped the strong light wave.

4. Figure 2 shows the dependence of the amplitude of the obtained molecular resonances on the parameter d, which determines the effective distance between the beams (Fig. 2a). Since the signal at the same saturation parameter is proportional to the initial absorption coefficient or to the pressure in the cell, the amplitudes of the resonances at the maximum have been normalized to unity. In the high-pressure region, the peak arises as a result of the inevitable weak diffraction overlap of the rays. It is seen from the diagram that with decreasing pressure the dependence of the amplitude of the resonances on the light-wave overlap parameter shifts into the region of large values of d. This shift amounts to approximately 0.8 mm when the SF_6 pressure in the cell is changed from 35 to 4.5 mtorr, and is inversely proportional to the pressure, a fact that can be attributed only to the effect of the transport of the "dip" from one light wave to the other by an amount equal to the mean free path of the molecules. The influence of the change of the parameter of saturation of SF_6 in the cell when the light fields are separated is excluded by the fact that when this parameter is decreased at the same pressure in the cell, by introducing calibrated attenuators, the course of the curves remains unchanged. A control experiment was also performed to exclude the influence of the change of the optical density $D = \kappa_0 L_{abs} p_{SF_6}$, which occurs with changing pressure p_{SF_6}. To this end, the saturation was produced by irradiation at the P(18) line of a CO_2 laser, for which κ_0 = 0.5 $cm^{-1}Torr^{-1}$, i.e., smaller by a factor of 2.6 at the same pressure. The position on the course of the curves following separation of the beams remains unchanged.

The transport of the dip is determined from the shift of the curves in Fig. 2 with decreasing pressure in the cell. It turned out to equal $p\Lambda_{cond}$ =

$(4.5 \pm 1.0) \times 10^{-4}$ cm-Torr, i.e., it coincides with the mean free path as given in [3, 4].

In the present experiment we observed the effect of spatial transport of the "hole" in the velocity distribution of the molecules and a narrow resonance upon saturation of the absorption in separated beams without participation of the effects of coherent interaction. The transition to lower pressures makes it possible to observe these effects, as was done by Ramsey in the radio-frequency band with the aid of a beam of atoms and two separate resonators [5].

In conclusion, the authors are grateful to E.L. Mikhailov and A.R. Kukudzhanov for help in preparing the experiment and to V.A. Semchishen for help with the performance of the experiment.

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NONLINEAR CONVERSION OF IR RADIATION INTO VISIBLE LIGHT AS A NEW METHOD OF ABSORPTION SPECTRAL ANALYSIS

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A considerable number of recent papers is devoted to the detection of infrared radiation by combining its frequency with the frequency of laser radiation in a nonlinear crystal [1 - 4]. Such a conversion can be a more sensitive method of observing IR radiation than direct detection with standard IR receivers [5].

The subject of our communication is the first experimental investigation of an absorption spectrometer for the near infrared, constructed on the principle of converting the IR radiation into visible light.

A block diagram of the setup is shown in Fig. 1. The broad-band source of IR radiation is a Nernst glower 11. This radiation passes through a cell with absorbing matter 22, focused by lens 13 into an $LiNbO_3$ crystal 16 and is mixed in it with radiation of an argon laser 3 operating at the 4880 Å line. The focusing of the mixed wave in the crystal was optimal [6]. A 90° $LiNbO_3$ crystal measuring $5 \times 5.5 \times 9$ mm was placed in oven 17, the temperature of which could be varied smoothly in the range 20 - 300°C. The temperature was maintained accurate to 0.02°C. When the crystal temperature was changed from 170 to 250°C, the IR spectrum sections from 2.8 to 3.2 μ were successively converted into the visible band. As a result of synchronous interaction of the "OO-e" type, radiation at the summary frequency was excited in the crystal and was registered with the aid of an ISP-51 spectrograph with an FEP-1 photo attachment modified to operate with an FEU-64 photomultiplier. A filter 20 was used to separate this radiation from the powerful laser radiation. To increase the sensitivity of the recording system, synchronous detection of the signal from the FEU-64 photomultiplier was employed. The sensitivity of the system made it possible to register reliably light signals with power 10^{-15} W.