doped with Cu) and to the lattice defect (in samples doped with different impurities and in the specially undoped samples), respectively. The observed low-frequency instabilities in $CdSnP_2(Cu)$ may be due to the capture of hot electrons by the repulsion centers $E_v + 0.92$ eV or $E_c - 0.03$ eV in samples with different amounts of the compensating acceptor impurity Cu. It is possible that an important role in the formation of the NVDC is played also by the conduction subbands lying above the absolute minimum of the band and having a higher density of states.

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GASDYNAMIC CW LASER USING A MIXTURE OF CARBON DIOXIDE, NITROGEN, AND WATER

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We report in this article that amplification of infrared radiation was observed when a heated mixture of carbon dioxide and nitrogen, with a small amount of moisture, was blown through a supersonic wind tunnel, and that lasing was produced when an optical resonator was installed in the working part of the tunnel.

Gasdynamic infrared lasers (GL), using molecular gases and in particular the CO_2-N_2 mixture, were proposed in [1, 2]. The general ideas of devices of this kind were discussed in [3, 4], and the theory of a CO_2-N_2 GL was developed in [1, 5 - 7]. The first attempt to observe population inversion of the electronic levels of xenon in a supersonic jet was described in [8]. In [9] it was demonstrated experimentally that the physical premises on which the action of a CO_2-N_2 GL is based are correct. The addition of helium to the mixture, in order to accelerate the relaxation of the molecules from the lower laser level, led to inversion of the population of the vibrational levels of the CO_2 molecule and resulted in pulsed lasing [10, 11]. A gas mixture of the required composition and temperature for a GL can be obtained by burning a mixture of carbon monoxide and air [12], or by mixing the gas in a supersonic jet [13].

Investigations of the gain of a supersonic stream ($M = 4 - 5$) were made with a previously described aerodynamic setup [9], modified so that the gas was expanded in a wedgelike jet with an aperture angle 13° and with a supersonic section 5 cm long. The stagnation temperature was 1000°K, the stagnation pressure 5 atm, and the dimensions of the critical section 0.5 × 100 mm. The beam of a single-mode single-frequency CO_2 laser was directed parallel to the larger dimension of the critical section and crossed the gas stream at the point of its emergence from the nozzle.

Figure 1 shows a time scan of the gain or absorption coefficient of a CO_2 laser operating on the transition $(00^01\ I = 15) \rightarrow (02^00\ I = 14)$ (R branch,

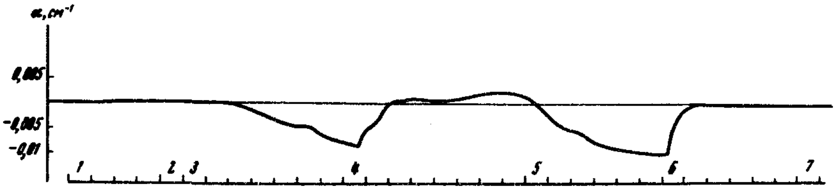

Fig. 1. Time scan of the gain or absorption coefficient in a supersonic gas stream. The time markers (lower scale) are 15 sec apart.

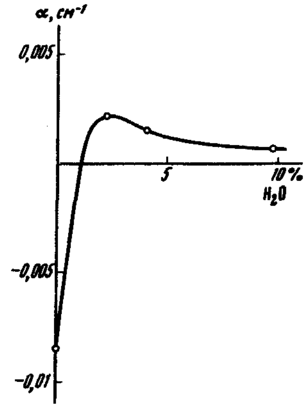

Fig. 2. Gain vs. water content in a mixture of carbon dioxide and nitrogen.

emission frequency 1074.63 cm^{-1}). The downward direction of the ordinate axis corresponds to absorption, and the upward direction to amplification. The time markers on the abscissa axis are spaced 15 seconds apart. At first (interval 1 - 2), the nozzle and the chamber into which the gas is ejected are evacuated (p = 2 Torr). Subsequently, during the startup time the pressure in the chamber is raised slowly to p = 4 Torr. In the initial stage of the start (interval 2 - 3), a mixture of carbon dioxide (24%) and nitrogen (76%), with low temperature (T = 290°K), containing not more than 0.05% moisture, is blown through the nozzle. Since the gas mixture is cold, the lower (02°0) and the upper (00°1) laser levels are practically empty, and no absorption can be registered. In the interval 3 - 4, after turning on electric heaters (point 3), the temperature of the gas rises gradually to 1000°K. With increasing temperature, the absorption increases. In the interval 4 - 5, water at a molar concentration 2 - 10% is added to the original gas mixture. The absorption in the gas stream then decreases to zero, and amplification appears. The water evaporates in the gas stream as the latter enters the heater. The water molecules cause accelerated relaxation of the CO_2 molecules from the lower level as the gas flows in the supersonic part of the nozzle. The decrease of the molecule lifetime at the upper laser level as a result of the CO_2 - H_2O collisions begins to manifest itself at larger water concentrations, when the population of the upper level manages to decrease considerably during the time of motion of the gas through the nozzle. A plot of the gain vs. the water content in the mixture is shown in Fig. 2. This plot is the result of reduction of the data recorded in the interval 4 - 5. After the supply of water is turned off (point 5), the absorption again increases to its previous level (interval 5 - 6). Then (point 6) the heaters are turned off, the supply of mixture is stopped, and nitrogen (with a moisture content not larger than 0.04%) is blown through the nozzle. The nitrogen does not cause attenuation of the laser beam (interval 6 - 7).

Measurement of the gain in the indicated gas mixture was made also at 947.73 cm^{-1}, corresponding to the transition (00°1 I = 15) → (10°0 I = 16) (P branch). The measurements have shown that inversion in the supersonic stream exists also for the level pair (00°1) - (10°0), but the gain is lower and amounts to 6×10^{-4} cm^{-1} at a water concentration 2.1%.

The optical resonator used to register the lasing effect was made up of one flat and one concave mirror (R = 2 m), with a distance 34 cm between them. The optical axis of the resonator was in the plane of the output section of the nozzle and was parallel to the generator of the wedge. The mirrors were gold-coated with a reflectivity 98%, the radiation was brought out of the resonator through an opening in the flat mirror (1 mm dia). The self-excitation regime occurred whenever 1 - 3% of water was added to a heated gas mixture of 14% CO_2 and 86% N_2. The output power of the GL was several watts.

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INFLUENCE OF CROSS RELAXATION PROCESSES ON THE γ RESONANCE SPECTRA OF Fe^{57}

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We report below a study of the influence of the cross relaxation processes on the γ resonance spectra of Fe^{57} in two model systems, constituting solutions of complexes produced in n-butyl alcohol in which ferric chloride is dissolved. In the case of complexes of the first type (K_1) the splitting of the spin sublevels of the Fe^{3+} ions by the crystal field does not exceed 10^{-2} cm^{-1}, whereas in the complexes K_2 the splitting is much larger and equals 2×10^{-1} cm^{-1}. The distances between the spin sublevels were estimated from the EPR spectra. The concentrations of the complexes K_1 and K_2 (Fig. 1a, 1b, 1c, and 2a, 2b; T = 88°K) were 5×10^{19} cm^{-3} and 10^{20} cm^{-3}, respectively. The rapidly-relaxing magnetic ion introduced in the solutions of the complexes was Co^{2+}.

It is known that cross relaxation processes that include a simultaneous change of the projection of the electron spin of two or more neighboring ions take place under certain conditions in a system containing two or more types of paramagnetic ions. Such processes have the greatest probability if the energy is strictly conserved in the spin system, i.e., the conditions $n\Delta E_{ab} = m\Delta E_{a'b'}$ are satisfied, where n is the number of particles going from level a to level b, m the number of particles going from level b' to level a', and ΔE_{ab} and $\Delta E_{b'a'}$ the energy intervals between the corresponding levels.

The greatest probability is posessed by the process of two-spin (resonant) cross relaxation (n = m = 1). The probability of such processes is determined by the proximity of the energy intervals between the spin sublevels of the interacting pair of paramagnetic ions. One can therefore expect the Co^{2+} ions to act differently on the complexes K_1 and K_2, which have different Stark splittings. To improve the resolution of the hyperfine structure of the γ-resonance spectra, the samples were placed in external magnetic fields [2].