therefore microscopic calculations of the dipole resonance of heavy deformed nuclei are necessary. It is also necessary to investigate the influence exerted on the giant resonance by surface oscillations of multiplicity higher than quadrupole.

The fact that the experimental curve lies systematically above the theoretical one in the 20 - 30 MeV region is apparently connected with the presence of giant quadrupole resonance. Calculations performed for ^{159}Tb and ^{165}Ho [5] show that the cross section for the absorption of quadrupole photons, concentrated in the 20 - 27 MeV region, contains five resonances and amounts to 7 - 8% of the total integral photodisintegration cross section.

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VIBRATIONAL RELAXATION OF CO_2 AND N_2 MOLECULES IN AN EXPANDING SUPERSONIC GAS JET

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The study of the vibrational relaxation of CO_2 molecules in a rapidly expanding supersonic gas jet was undertaken in order to develop a gasdynamic laser (GDL) based on a mixture of carbon dioxide and nitrogen [1, 2]. The general idea of devices of this kind was advanced by Hurle and Hertzberg [3, 4], and model calculations of the flow of a carbon dioxide and nitrogen mixture are reported in [2, 3 - 7]. The main idea of the GKL is that the flow of gas beyond a Laval nozzle is not in vibrational equilibrium. If the lifetime of the CO_2 molecule at the upper laser level is longer than at the lower one, then the vibrational relaxation to the temperature of the flowing gas can lead to a temporary population inversion, and hence to an amplification of infrared (IR) radiation in a supersonic gas stream.

We investigate here the absorption of IR radiation from a CO_2 laser in a supersonic gas jet produced by escape of pre-heated gas from a slit to a vacuum. The stagnation temperature of the mixture of nitrogen and carbon dioxide is $T_0 = 1000°K$, the stagnation pressure is $P_0 = 4.2$ atm, the slit dimensions are 0.5 x 100 mm, and the observation coordinate, where the laser beam crosses the jet, is 1.6 cm away from the plane of the slit (Fig. 1). Conversion from the absorption coefficient for the vibrational component P(20) of the $(10^00) \rightarrow (00^01)$ transition to the populations of the vibrational levels is effect with account taken of 1) the gas temperature in the jet and the concentration of the CO_2 in the mixture, 2) the molecule distribution over the vibrational levels (the vibrational temperature was assumed to equal the gas temperature in the jet), 3) the joint action of

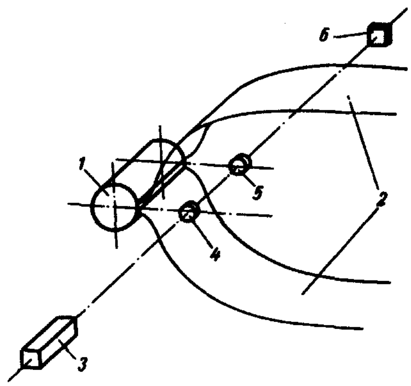

Fig. 1

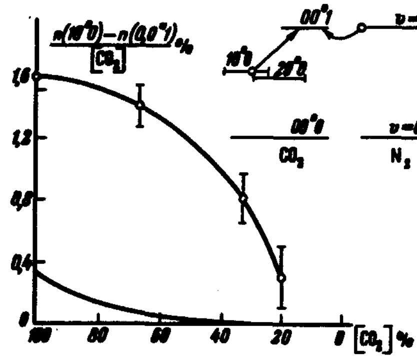

Fig. 2

Fig. 1. Experimental setup: 1 - forechamber with slit, 2 - flat supersonic jet, 3 - CO_2 laser, 4, 5 - vacuum windows in working chamber, 6 - laser radiation receiver.

Fig. 2. Difference of relative populations of levels (10^00) and (00^01) of the CO_2 molecule in a gas jet as a function of the concentration of the carbon dioxide in the mixture.

the Doppler and shock broadening of the line [8], and 4) the difference between the cross sections for the optical line broadening in collisions with the CO_2 and N_2 molecules [9]. The measurement results for four CO_2 concentrations in the mixture are shown in Fig. 2. The ordinates represent the relative population difference (RPD) of the levels (10^00) and (00^01), and the abscissas the CO_2 concentration. The solid line in the upper part of the figure shows the equilibrium value of the RPD for the same levels; this value corresponds to the temperature of the flowing gas in that part of the jet where the absorption coefficient is measured.

It follows from a comparison of the observed and equilibrium RPD values that the gas flow is vibrationally unbalanced to a high degree, the degree of non-equilibrium increasing with increasing nitrogen content in the mixture; this is attributed to the increase of the rate of cooling of the gas jet (the adiabatic exponent increases from 1.17 to 1.30). From the value of the RPD for pure CO_2, using the temperature profile and the gas-density profile along the jet, we can estimate the relaxation time of the CO_2 molecules in the jet. It turns out that the relaxation time is about one-tenth as short as for the gas relaxation behind a shock-wave front [12]. The reduction of the time of vibrational relaxation in an expanding gas was observed for flow of nitrogen and carbon monoxide in nozzles [13, 14]. The appreciable decrease of the RDP for mixtures with large nitrogen contents is due to the increase of the CO_2 molecules at the upper laser level (00^01) due to the selective transfer of vibrational excitation [10, 11] from the N_2 molecules to the CO_2 molecules, inasmuch as the nitrogen molecules, which have an appreciably larger relaxation time, remain in the jet a longer time in the excited state. Another possible explanation, connected with the depletion of the lower laser level (10^00) due to the acceleration of the CO_2 molecules in mixtures with a large nitrogen content, would not be correct, since special experiments have shown that the lifetime of the CO_2 molecule at the lower levels in mixtures with large nitrogen contents increases somewhat compared with the lifetime in the pure carbon dioxide. If the mixture is diluted with more than 80% of nitrogen, the no population inversion may occur under chosen concrete conditions of gas flow, since the temperature of the "freezing" of the populations of the vibrational levels of the CO_2 molecules, approximately 500°K, is close to the limiting cooling temperature T_{lim}, above which no inversion can appear at all at a vanishingly small content of carbon dioxide in the mixture and at sudden cooling of the gas. It follows from [1, 2] that

$$T_{lim}/T_0 = E_1/E_2 = 0.59,$$

where E_1 and E_2 are the energies of the lower and upper laser levels.

Our investigation confirms experimentally the correctness of the main physical premises underlying the action of a GKL using a mixture of carbon dioxide and nitrogen.

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SUPERCONDUCTIVITY OF ARSENIC AT HIGH PRESSURES

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The elements of the fifth group of the periodic system Bi [1], Sb [2], and P [3, 4] become superconducting at pressures exceeding 25, 70, and 110 kbar, respectively.

According to the data of [5], a sharp drop is observed on the plot of the electric resistance of As against pressure at P = 100 kbar; this drop is connected with a polymorphic transition. However, attempts to observe superconductivity of As at high pressure yielded no affirmative result [4, 6]. One might assume that this negative result is connected with the fact that As becomes superconducting at a lower temperature than that used in the investigation.