$(4.5 \pm 1.0) \times 10^{-4}$ 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 × 5.5 × 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.

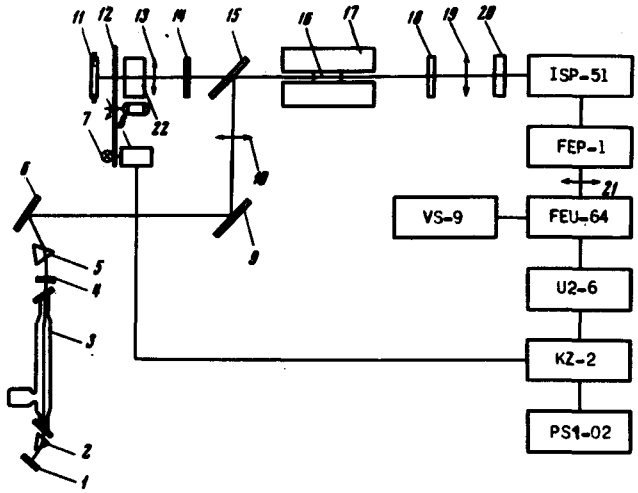

Fig. 1. Experimental setup: 1 - total-reflection mirror R 10 M; 2, 5 - quartz prisms, 3 - laser, 4 - output mirror R 2 M, r = 4%; 6, 9, 15 - rotating dielectric mirrors, 7 - lamp, 8 - photodiode, 10 - lens F 192, 11 - Nernst glower, 12 - modulator, 13 - quartz lens F 112, 14 - silicon plate, 16 - crystal, 17 - oven, 18 - crystalline-quartz plate, 19 - lens F 110, 20 - filter, 21 - lens F 25, 22 - cell.

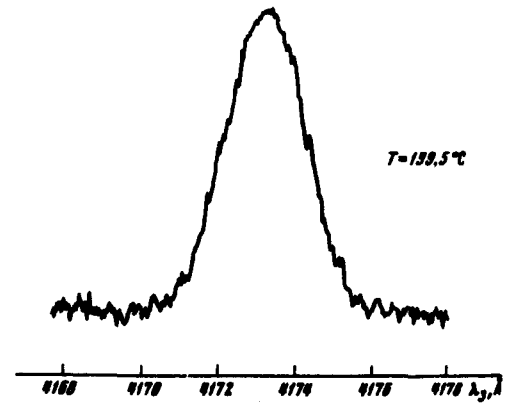

Fig. 2. Spectrum of radiation at the summary frequency.

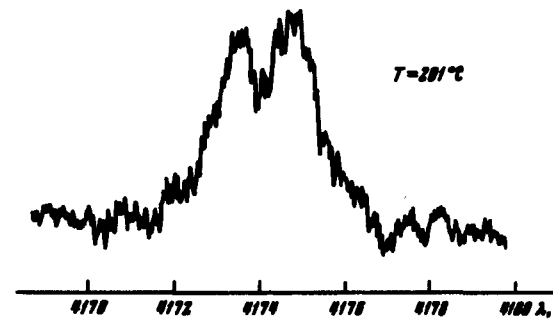

Fig. 3. Converted radiation spectrum obtained when the cell 22 is filled with gaseous ammonia. The dip corresponds to the absorption line of NH_3 in the 2.89 μ region.

Figure 2 shows the spectrum of the conversion radiation in the case when the cell with the absorbing substance is removed. The width of the spectrum at the 1/2 level is 13.5 cm^{-1}. The spectrum of the converted radiation, recorded with the cell 22 filled with gaseous ammonia, is shown in Fig. 3. This spectrum shows clearly a dip corresponding to the absorption line of the ammonia in the region of 2.89 μ. In recording this spectrum we used the resolution limit of the ISP-51 spectrograph (~2.8 cm^{-1}), and the crystal temperature was maintained such that the center of the transformed band of the IR radiation (Fig. 2) corresponded to the center of the ammonia absorption line.

In the described scheme of the IR spectrometer, the resolution is determined by the resolution of the ISP-51 spectrograph, and amounts to 2.8 cm^{-1}. Much more promising is the use of a scanning Fabry-Perot interferometer as the spectral instrument for the visible band. It is necessary here, however, that the total width of the transformed section of the IR spectrum (the apparatus function of the converter) be not larger than the dispersion region of the interferometer. For the case of 90° synchronism at the optimal focusing, the width of the converted section of the spectrum is [1]

$$\Delta\nu_1 = \frac{1}{L}\left(n_3^\circ - n_1^\circ + \lambda_1 \frac{dn_1^\circ}{d\lambda_1} - \lambda_3 \frac{dn_3^\circ}{d\lambda_3}\right)^{-1},$$

where the subscripts 1 and 3 pertain to the IR band and to the summary frequency, respectively. For our case this quantity should amount to 2.2 cm^{-1}.

The difference between the experimentally obtained width (13.5 cm^{-1}) and the theoretical one is determined principally by the inhomogeneity along the crystal at our disposal. The presence in the crystal of several regions with different values of the refractive index was verified by the generation in it of the second harmonic of 1.15-μ He-Ne laser radiation [7].

Thus, when a $LiNbO_3$ crystal of good quality is used it is realistic at present to expect a resolution of ∿0.1 cm^{-1} in the near infrared.

In addition, the discussed method makes it possible to register photographically individual sections of the IR spectrum. This may be of interest if it is necessary to register the IR spectra of pulsed processes, when scanning is impossible.

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HOLOGRAPHIC METHOD OF AMPLITUDE-PHASE CORRECTION OF LASER BEAMS

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One of the main problems of quantum electronics is to obtain a maximal axial brightness of stimulated emission, for which purpose it is necessary to use a nearly-plane wave front and homogeneous amplitude distribution over the cross section of the beam. As is well-known, this requirement is approximately satisfied only by the lowest transverse mode TEM_{00}, but it occupies the minimum volume in the active medium. Modes with higher transverse indices have a much larger volume and make it possible to obtain a higher radiation power. The amplitude structure (mode spots) and the phase structure (jumps of the phase π between neighboring spots) of the beams become, however, more complicated. As a result, the axial brightness of the radiation even decreases compared with the TEM_{00} mode.

It is enticing and of unusually great practical importance to develop a method of converting radiation modes with arbitrary transverse indices (in the general case - beams with a complex irregular front) with minimum loss into a flat Gaussian beam[1]. This makes it possible to increase greatly the axial brightness of the radiation of real lasers, especially those operating with imperfect media.

[1] Within the framework of ordinary optics it is possible in fact only to compensate for the spherical component of the phase front and to separate the corresponding regular part of the beam, a process that entails considerable losses.