SUBMILLIMETER-BAND GAS LASER PUMPED BY A CO_2 LASER

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Submitted 24 October 1972
ZhETF Pis. Red. 16, No. 11, 592 - 594 (5 December 1972)

Following the development of effective and discretely-tunable CO_2, N_2O, and CO lasers, it became possible to use them to pump heavy-molecule gas lasers generating in the submillimeter band. Foreign publications report realization of such lasers with the molecules CH_3F, CH_3OH, C_2H_3Cl, NH_3, CH_3CN, and CH_3CCH [1 - 4]. Undisputable advantages of the new type of submillimeter laser over the known H_2O, HCN, and SO_2 lasers, which are excited by electric discharge, are the possiblity of sealed operation, considerably higher efficiencies, and the large number of generation lines, covering the entire submillimeter band and part of the millimeter band.

We report here observation, for the first time, of the laser effect in the submillimeter band using the molecules $C_2H_2F_2$ (1.1 difluorethylene), CH_2CHCN (vinyl cyanide), and CH_3HN_2 (methylamine), excited by a CO_2 laser.

The experimental setup consists of a tunable CO_2 laser, a submillimeter laser, radiation indicators, and measuring apparatus. The CO_2 laser is 1.3 m long and its discharge-tube diameter is 18 mm. One of the resonator mirrors has zero transmission, and the other is an echelette (75 lines per mm), ensuring tuning of the laser frequency on the P and R branches of the $00^01 - 02^00$ and $00^01 - 10^00$ transitions of the CO_2 molecule. The laser operates in the cw regime. The output power is decoupled at the zero-order diffraction maximum. The power level in the entire tuning band ranges from 4 to 10 W. Continuous tuning of the CO_2 laser within the limits of the lasing line is by translational motion of the zero-transmission mirror. Part of the laser output power is diverted to monitor the frequency and the power level, and the remainder enters the resonant cavity of the submillimeter laser. The latter is 1.2 m long and has a tube diameter 56 mm. The resonator is made up of copper mirrors with curvature radius 2 m. One of the laser mirrors has an entrance opening of 15 mm diameter, and the other an exit hole of 4 mm diameter. The entrance window of the submillimeter laser is made of crystalline NaC, and the exit window is made of crystalline quartz, which cuts off the radiation in the 10 μ region. The submillimeter laser can operate both with continuous flow of the gas and in the "sealed-off" regime. The submillimeter radiation is recorded with a point-contact detector of beryllium bronze paired with InSb [5] and with a pyroelectric detector. The wavelength of the submillimeter radiaton was measured with a Michelson interferometer with accuracy $\pm 2 \times 10^{-3}$. The power was measured with a calorimeter, and the polarization with a one-dimensional wire grating with 40 μ pitch. The experimental results are given in the table.

The polarization of the submillimeter radiation is indicated relative to the polarization of the CO_2 laser beam. It is seen from the table that several submillimeter wavelengths can be obtained with one and the same working transition of the CO_2 laser. In this case, each such wavelength corresponds to a separate setting of the submillimeter laser and of the CO_2 laser within the limits of the transition contour. Two or more submillimeter wavelengths can be generated at a fixed setting of the CO_2 laser and an individual setting of the submillimeter laser.

Lasing on all submillimeter lines was observed in the cw regime. The power of the submillimeter radiation on each individual line was not optimized. The properties of the laser resonator became noticeably worse in the region near 1 mm. It is seen, however, that the optically-pumped submillimeter lasers are not inferior to electric-discharge lasers in their output power levels, and are

Working molecule	Submillim. radiation λ, microns	Submillimeter power, P mW	CO_2 laser λ, microns	Relat. polariz.	Vapor press. mm Hg
$C_2H_2F_2$	288.5	0,30	10,513	‖	$3 \cdot 10^{-1}$
	375.0	1,60	10.513	‖	$3 \cdot 10^{-1}$
	458,0	0,20	10,695	‖	$1,5 \cdot 10^{-1}$
	464.3	0,30	10,245	‖	$2,5 \cdot 10^{-1}$
	554,4	3,00	10,532	⊥	$8 \cdot 10^{-2}$
	663,3	0,20	10,632	‖	$1,5 \cdot 10^{-1}$
	890,0	0,30	10.611	‖	$1 \cdot 10^{-1}$
	890,1	0,20	10,611	‖	$1 \cdot 10^{-1}$
	990.0	0,20	10,611	‖	$1 \cdot 10^{-1}$
CH_2CHCN	586,6	0.32	10,591	‖	$1,5 \cdot 10^{-1}$
	584,0	0,06	10,513	⊥	$1 \cdot 10^{-1}$
	574,4	0,30	10.274	⊥	$2,5 \cdot 10^{-1}$
	550.0	0.06	10,532	‖	$1,5 \cdot 10^{-1}$
	270.6	0,06	10,653	⊥	$1 \cdot 10^{-1}$
CH_3NH_2	251,3	0,30	9.585	‖	$4 \cdot 10^{-1}$
	218,0	1,00	9,585	‖	$4 \cdot 10^{-1}$
	198,0	1,00	9,585	‖	$4 \cdot 10^{-1}$
	148,5	10,00	9.585	⊥	$4 \cdot 10^{-1}$

much superior in efficiency, dimensions, number of generation lines, and frequency of the spectrum.

The authors thank Yu.N. Petrov, B.I. Makarenko, and M.N. Efimenko for help in producing the experimental setup.

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ULTRASHORT SRS PULSES AND MULTIFOCUS STRUCTURE OF LIGHT BEAMS

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Submitted 25 October 1972
ZhETF Pis. Red. 16, No. 11, 595 - 599 (5 December 1972)

In 1966, Maier et al. [1, 2] observed ultrashort pulses of the first Stokes component of stimulated Raman scattering (SRS). These pulses were produced at the end of a cell with the investigated liquid and propagated in a direction opposite to that of the laser beam. They also noted a correlation between the occurrence of these pulses and the appearance of the so-called "filaments" when sufficiently strong radiation propagates in a nonlinear medium. Loy and Shen