laser operates exceeds the ionization energy of the gas. In this case it is necessary that the gain of the electromagnetic wave in the laser exceed the attenuation due to the photoionization of the atoms. This condition takes the form

$$\frac{w}{\Delta\omega} \cdot \frac{\pi^2 c^2}{\omega^2} N^* \gg \sigma_{phot} N_a , \qquad (3)$$

where N^* is the average density of the excited ions on the path of the beam, N_a the density of the atoms, ω the transition frequency, $\Delta\omega$ the width of the spectral line produced as a result of the spontaneous emission, and w the probability of spontaneous emission per unit time. Although the quantity N^*/N_a is very small, the quantity $\pi^2 c^2/\omega^2 \sigma_{phot}$ is quite large. Therefore, by varying the laser parameters, it is possible to create conditions under which the foregoing inequality is satisfied. Then a laser constructed in according with the indicated scheme will generate photons with energies exceeding the ionization energy of the atoms. It must be noted that a beam of such photons has in air a path length of about 10^{-2} cm and is absorbed as a result of photoionization of the molecules.

The proposed laser makes it possible to obtain amplification in the region of photon energies on the order of ten electron volts. By varying the angle between the ion beam and the laser beam, and also the velocity of the ion beam, it is possible to vary continuously the frequency of the electromagnetic wave in a small frequency interval by using the Doppler frequency shift. For the same reason, it is possible to operate in such a design at one of two frequencies, $\omega = \omega_0 \pm v_x/c$, where ω_0 is the frequency of the transition between the ion levels, and v_x is the beam velocity along the resonator axis.

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SUBMILLIMETER CW GAS LASER

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The development of a cw laser using water vapor and chemical compounds containing cyan was reported in [1]. The laser generated at several wavelengths from 79 to 340 μ but, as reported in [1], the cw power did not exceed several microwatts.

To assess the possibility of increasing the power, we constructed an experimental laser 3 m long with inside tube diameter 70 mm. The mirrors of the non-confocal resonator were made of glass and had a diameter 70 mm. The glass surface was silvered by vacuum sputtering. The radiation was extracted from the resonator through an opening in the center of one of the mirrors. The output window of the laser was sealed with a sapphire plate 0.3 mm thick for the

0.3 mm band and with a teflon film at shorter wavelengths. Flow-through gas filling was used. Provision was made for regulating the pressure and for rapidly evacuating the spent gas.

To observe the emission in the entire band, we used a pyroelectric detector. The wavelength and the power we measured with wave meters and with calorimeters for the submillimeter band, developed at the Kharkov University. The laser design was such that the resonator could be tuned by varying the length. The results of some of the measurements are given in the table.

Active medium	H_2O			$(C_2H_5)_2O + N_2$	
Wavelength (μ)	27.9	79	118	311	337
Power (mW)	3	0.15	0.2	3	2.2
Mirror curvature rad. (m)	$R_1 = \infty$; $R_2 = 4$			$R_1 = 4$; $R_2 = 4$	
Output opening rad. (mm)	3	5	3	4	4
Disch.cur. (A)	0.5	0.5	0.5	0.35	0.35

The water-vapor laser generated at 27.9 μ regardless of the resonator length setting. The emission at this wavelength was cut off with a paper filter. Generation at all other lines occurred only at a definite setting of the resonator.

When acetonitryl CH_3CN was used as the medium generation was obtained at 311 and 337 μ, but the the power levels were approximately half those obtained with a mixture of ether vapor $(C_2H_5)_2O$ with N_2. We investigated discharges in vapor of benzene C_6H_6, cyclohexane C_6H_{12}, and acetone $(CH_3)_2CO$. No generation was observed in pure vapors, but when mixed with nitrogen(or even air) each of them generated at the same lines of the cyan group - 311 and 337 μ. The most power was obtained with acetone (1.6 mW at 337 μ).

Unfortunately, a solid orange films is produced on the tube walls when these organic substances are used. After prolonged operation, the film peals off, covers the working region of the cavity, and the laser stops operating.

The power levels attained in this investigation cannot be regarded as limiting for a laser having the given dimensions.

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ERRATA

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In the article by A. A. Galkin et al. (p. 324), the upper figure should be labeled "a" and the lower "b."

In the article by M. Ya. Azbel' et al. (p. 340, 10th line from top), replace "... in different regions:" by "...in different regions (see the figure):"