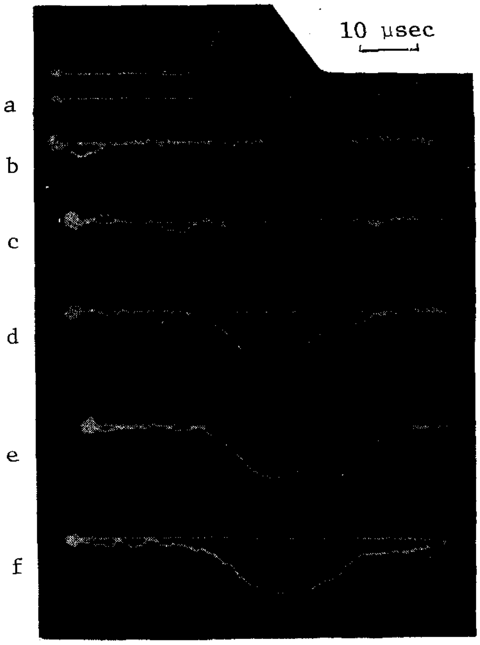

Fig. 2. Variation of magnetic moment of sample at $\phi = 0$ (a) and of the light intensity at intermediate wavelengths at angle 0 (b), 7'(c), 21'(d), 42'(e) and 56'(f) between the c_4 axis of the sample and the magnetic field direction.

ly from λ_a to λ_c. In our opinion this indicates unambiguously that in a strictly oriented sample the flipping of the MnF_2 sublattices is a first-order phase transition. In a narrow but finite interval of fields there is realized in the crystal an interemediate state, wherein there coexist two phases, antiferromagnetic ($\vec{\ell} \parallel c_4$) and with flipped sublattices ($\vec{\ell} \perp c_4$). The most clear-cut evidence of the existence of both phase is that in the vicinity of the critical field H_c light is absorbed simultaneously at two frequencies (wavelengths λ_a and λ_c), each of which is characteristic of one of the phases (Fig. 1). All these results are in good agreement with the data on the magnetic investigations of the intermediate state in the antiferromagnetic crystal MnF_2 [2]. Some discrepancies (different values of the critical angle ϕ_c, viz., ~20' in our measurements and ~30' according to the data of [2]; the appearance of absorption at the intermediate frequency even at ϕ = 7') are due to the fact that our sample was disk-like in shape, the temperature was higher (20.4°K), and the absorption bands had noticeable wings. These details will be discussed in a more detailed article.

In conclusion, we sincerely thank K. L. Dudko and N. F. Kharchenko for useful discussions.

Postscript. In a paper published after this article was written, A.R. King and D. Paquette (Phys. Rev. Lett. 30, 662, 1973) also demonstrate the existence of an intermediate state in MnF_2 by methods of optical absorption spectroscopy and NMR, and present photographs of the sample domain structure in the critical field.

[1] J. S. Jacobs, J. Appl. Phys. 32, 61S,(1961); 40, 1025 (1969).
[2] K. L. Dudko et al., Zh. Eksp. Teor. Fiz. 61, 678 (1971) [Sov. Phys.-JETP 34,362(1972)].
[3] V. G. Bar'yakhtar et al., ZhETF Pis. Red. 9, 634 (1969) [JETP Lett. 9, 391 (1969)].
[4] V. V. Eremenko et al., Zh. Eksp. Teor. Fiz. 47, 1733 (1964)[Sov.Phys.-JETP 20,1165(1965)]
[5] V. V. Eremenko et al., Phys. Stat. Solidi 33, K47 (1969).

HIGH-EFFICIENCY VISIBLE-BAND LASER USING DYES

M. I. Dzyubenko, I. G. Naumenko, V. P. Pelipenko, and S. E. Soldatenko
Institute of Radiophysics and Electronics, Ukrainian Academy of Sciences
Submitted 28 May 1973
ZhETF Pis. Red. 18, No. 1, 43 - 46 (5 July 1973)

The output characteristics of an organic-dye laser pumped by coaxial-lamp light were investigated. The feasibility is demonstrated of obtaining efficiencies higher than 1% at an input energy exceeding 10 J in the visible band; this is done by optimizing the lamp-supply circuit.

The efficiency of organic-dye lasers is determined by the effectiveness of the pumping system and by the spectroscopic and photochemical properties of the active molecules. Owing to T-T absorption, appreciable energies and efficiencies can be obtained for most dyes only in the case of short pump pulses. On the other hand, reducing the pulse duration lowers the pumping efficiency, owing to the deterioration of the impedance matching in the discharage circuit, due to the decreased accumulation capacity, and the shift of the lamp emission to the UV region, due to the increase in the discharge temperature.

The highest efficiency (0.75% at E_{out} = 1.5 J) [1] and the highest lasing energy (E_{out} = 110 J at ~0.3% efficiency) [2] were obtained so far with solution of rhodamine-6G, which can be pumped with pulses of large duration. Lasing with other compounds can be obtained by using short-pulse pumping systems [3 - 5], but the attainable efficiences and emission energies are relatively low.

We describe here a laser using dye solutions that emit in the 435 - 650 nm band and have output energies and efficiencies greatly exceeding those previously published for all dyes except rhodamine-6G. Lasing was excited with a coaxial flash lamp. The discharge was produced in a ring gap 2 - 2.5 mm thick and 260 mm long between two quartz tubes. The active solution was pumped through the internal lamp cavity (10 mm diam). The outer tube was coated with magnesium oxide powder to improve the utilization of the discharge light energy.

The lamp was fed from an 18-μF capacitor. This capacitance was chosen with an aim at increasing the wave impedance of the discharge circuit. For the same purpose, and also to increase the pump-intensity growth rate, measures were taken to decrease the discharge-circuit inductance.

In the absorption band of the dye, the lamp emission power, which is comparable with the generation energy of 4-methylumbelliferone (4MU), increases with increasing xenon pressure in the lamp. At pressures above 15 Torr, this growth, however, is negligible, and therefore, to increase the service life of the lamp, the experiments were performed at pressures 17 - 20 Torr, and the discharge energy usually did not exceed 1.5 kJ. Under these conditions, the pump pulse duration at half intensity amounted to τ_p = 3 - 4 μsec with a rising front τ_f = 1.5 - 0.8 μsec. The oscillograms of the light pulse and of the discharge current are shown in Fig. 1. The large value of the current damping constant is evidence of good electric matching. Depending on the voltage and on the Xe pressure, 60 - 80% of the energy is radiated by the lamp during the first half-cycle of the discharge current.

The resonator was made up of a plane-parallel uncoated glass plate and flat dielectric mirrors for each of the dyes, with reflectance of about 98%. The radiation energy was measured with a standard IKT-1M calorimeter.

The list and characteristics of the lasing of the tested substances are given in the ~~tab-~~ table. The solvent in all cases was methyl alcohol. It should be noted that the concentration and reflectance of the mirrors were close to optimal only for 4MU at pump energies up to 1 kJ.

The dependence of the generated energy (E_{out}) on the pump energy (E_p) is shown in Fig. 2. We see that E_{out} can be increased by increasing E_p, but the laser efficiency is then decreased. The saturation observed in the figure is due to a considerable degree to the photodecay of the molecules of 4MU, which is one of the optically stablest of the lasing compounds. If the freshly prepared solution is not pumped through the cell, then excitation of the solution by two successive pulses with E_p = 900 J leads to a decrease of E_p in the second pulse by a factor of 5. Elimination of the photodecay of the active molecules improves the laser characteristics appreciably.

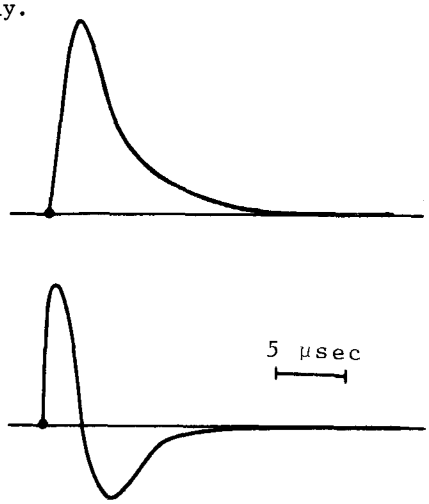

Fig. 1. Oscillograms of pump pulse (top) and of discharge current (bottom)

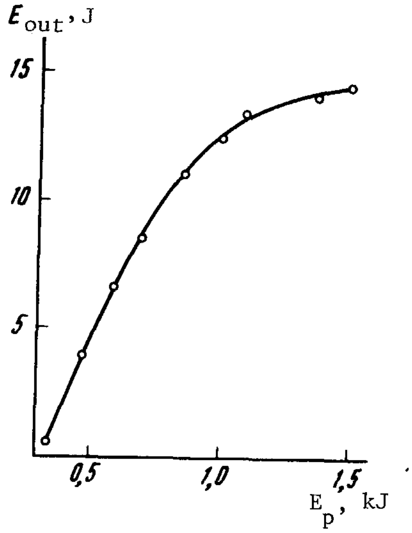

Fig. 2. 4MU generator energy vs pump energy.

Dye	λ_{gen}, nm	Concentr. mol/1	Eff.% (max)	E_{out}, J at max eff.	E_{out}, J at E_{pump} = 1,5 kJ	P_{out}, MW
Cresyl violet	650	10^{-4}	0,11	1,4	1,6	2
Rhodamine-6G	590	10^{-4}	1,1	12	15	7,5
Rhodamine unsubstituted	560	10^{-4}	0,03	0,3	0,4	0,6
7-oxy-4-methyl-3-ethylcoumarin	460	$5\cdot10^{-4}$	0,55	6	7.6	4
4-methylumbelliferone (4MU)	455	$5\cdot10^{-4}$	1,25	12,5	14,5	7,25
7-amino-4-methylcoumarin	435	$5\cdot10^{-4}$	0,13	2	2	2,5

[1] S. A. Mikhnov, M. I. Zybin, and V. S. Strizhnev, Zh. Prikl. Spektr. 15, No. 5, 947(1971).

[2] F. N. Baltakov, V. A. Barikhin, V. G. Kornilov, S. A. Mikhnov, A. N. Rubinov, and L. V. Sukhanov, Zh. Tekh. Fiz. 42, 1459 (1972) [Sov. Phys.-Tech. Phys. 17, 1161 (1973)].

[3] M. Bass, T. F. Deutsch, and M. J. Weber, Tech. Report R-69, Raytheon Co., Waltham, Mass. Published also in : Lasers, Vol. 3, NY, 1971.

[4] Yu. N. Yanait, G. A. Abakumov, G. I. Kromskii, A. P. Simonov, V. V. Fadeev, and R. V. Khokhlov, ZhETF Pis. Red. 13, 616 (1971) [JETP Lett. 13, 438 (1971)]

[5] M. I. Dzyubenko, A. Ya. Matveev, and I. G. Naumenko, Prib. Tekh. Eksp. No. 1, 171 (1972).

CONTRIBUTION TO THE NONLINEAR THEORY OF THE "MODIFIED" DECAY INSTABILITY

B. A. Al'terkop, A. S. Volokitin, V. D. Shapiro, and V. I. Shevchenko

Submitted 24 April 1973; resubmitted 24 May 1973
ZhETF Pis. Red. 18, No. 1, 46 - 49 (5 July 1973)

An expression is derived for heat flow in a plasma in which the electron mean free path exceeds the characteristic scale of the inhomogeneity. This expression is used to derive a formula for the electron temperature in a plasma corona as a function of the laser power.

We investigate the nonlinear stage of the "modified" decay [1] of a Langmuir wave into a Langmuir satellite and a low-frequency (LF) perturbation of the acoustic type, when the instability increment greatly exceeds the frequency of the sound and the perturbation grows aperiodically with time.

The nonlinearity mechanism considered by us consists in the reaction of the pump wave on the growth of the perturbation. In ordinary decay, such a mechanism leads to establishment of a equilibrium state in which the energy of the wave motions is transferred mainly between the high-frequency modes (the energy in the sound wave is smaller in the ratio ω_S/ω_L) [2]. We shall show that in the case of an aperiodic instability no such oscillating equilibrium is established, and the amplitude of the LF perturbations increases to an appreciably larger value, at which considerable modulation of the plasma density takes place. Under these conditions, irreversible dissipation of the pump-wave energy becomes possible and the electrons and ions can be heated.

The system of equations describing the "modified" decay of the Langmuir waves is written in the form[1])

$$\frac{d}{d\tau}(C_0 e^{i\alpha_0}) = -i C_1 S e^{i(\alpha_1 - \Delta_1\tau - \phi)}, \qquad (1)$$