It is seen from Fig. 1 that the resonance which we observed in weak fields is a mixed electron-nuclear resonance. At sufficiently strong fields, when the frequencies of the nuclear and electronic resonances differ greatly, we have a weakly perturbed muclear magnetic resonance spectrum. With increasing magnetic field, the radio-frequency power is absorbed by the electrons and nuclei together.

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[1] Heeger, Portis, Teaney, and Witt, Phys. Rev. Lett. 7, 308 (1961); J. Appl. Phys. 34, 1052 (1963); Phys. Rev. 135, 1616 (1964); Phys. Rev. 136, 1316 (1964).

[2] Borovik-Romanov, Kreines, and Prozorova, JETP 45, 64 (1963), Soviet Phys. JETP 18, 46 (1964).

[3] D. Shaltiel and H. J. Fink, J. Appl. Phys. 35, 849 (1964).

[4] Nakamura, Minkiewicz, and Portis, J. Appl. Phys. 35, 842 (1964).

[5] De Gennes, Pincus, Hartman-Boutron, and Winter, Phys. Rev. 129, 1105 (1963).

[6] E. A. Turov and V. G. Kuleev, JETP 48, No. 7 (1965), in press.

[7] N. Yu. Ikornikova, Kristallografiya 6, 745 (1961), Soviet Phys. Crystallography 6, 594 (1962).

[8] I. N. Kalinkina, JETP 43, 2028 (1962), Soviet Phys. JETP 16, 1422 (1963).

1) The investigated samples were obtained by a hydrothermal method by Ikornikova [7] at the Institute of Crystallography.

DEPENDENCE OF SPECTRAL COMPOSITION OF STIMULATED EMISSION ON THE VELOCITY OF MOTION OF THE CRYSTAL

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The stimulated emission from solid media (crystals, glasses, etc.) is known [1,2] to occur at many cavity modes. The width of the spectrum is determined here by the number of axial (longitudinal) modes engaged in the generation. This number can reach many dozens [3], greatly reducing the monochromaticity and the spectral density of the radiation.

We predicted [4] and by now observed experimentally 1) the effect of narrowing down the stimulated emission spectrum of a crystal moving relative to the resonator.

The inhomogeneity of the inverse population, resulting from the spatial inhomogeneity of the modes in the cavity (which in turn causes the multimode nature of the spectrum), becomes smoothed out when the crystal moves. Because of this, the number of generated modes decreases, the emission spectrum becomes narrower, but the total intensity remains unchanged, so that the spectral density of the stimulated emission increases.

A ruby crystal 12 cm long was made to execute reciprocating motion with maximum velocity ~ 35 cm/sec inside a plane resonator with distance 50 cm between mirrors. The light-pump pulse could be turned on at different phases of crystal motion, corresponding to reciprocating velocity relative to the resonator from 0 to ~ 35 cm/sec. The spectrum of the induced emission was analyzed with the aid of a IT-51-30 Fabry-Perot etalon. The generated emission, passing through a telescopic system of two lenses and a ground glass, filled the Fabry-Perot interferometer. The interference patterns were photographed by a lens of 1000 mm focus. Measurements were made at different air gaps between mirrors, namely 30, 10, and 5 mm.

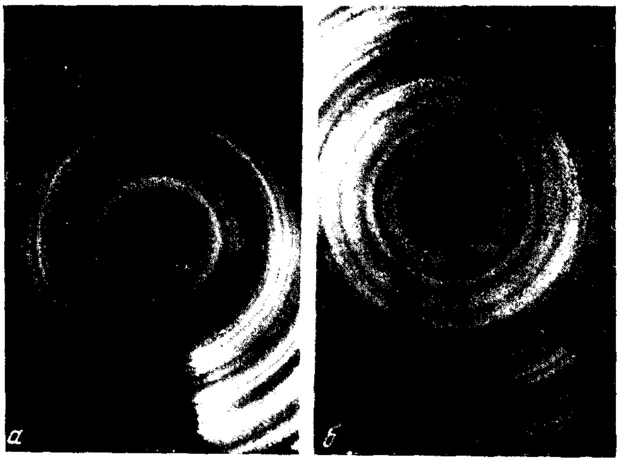

Fig. 1. Fabry-Perot interference patterns at near-threshold pumping.

a - stationary crystal, b - moving crystal

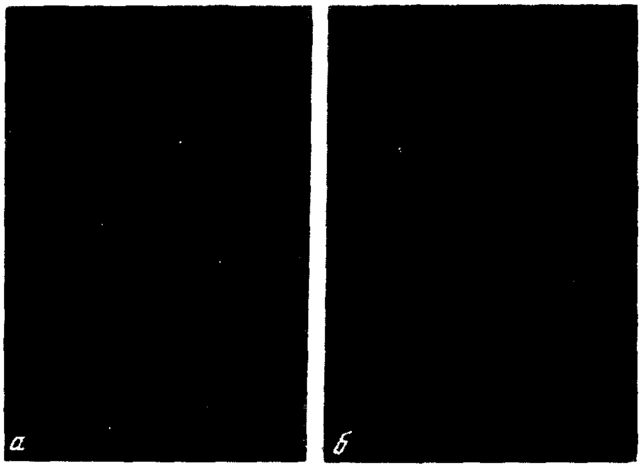

Fig. 2. Fabry-Perot interference patterns at large pump power.

a - stationary crystal, b - moving crystal

Figure 1 shows interference patterns (5 mm gap) of emission from the stationary and moving (~ 35 cm/sec) crystal near the lasing threshold (V = 1800 V). 2) Comparison shows that when the crystal moves a whole series of side modes ceases to generate, whereas the intensity of the central modes increases.

This means that as the crystal moves the central modes draw energy from the large volume occupied by the active centers (compared with the stationary crystal), thereby suppressing the weaker side modes.

Figure 2 shows Fabry-Perot interference patterns (5 mm gap) for the case of a higher pump level (V = 2000 V). At the same ~ 35 cm/sec velocity, the effect of the increased spectral density is less pronounced. This means (as follows from theoretical considerations) that in order to approach single-mode generation it is necessary to increase the velocity of the crystal.

It must be pointed out that the interference pattern for the moving crystal, shown in Fig. 2, contains two systems of rings. In the case of small pump power, the second system of rings is so weak that it reproduces poorly on the photographs. In general, the motion of the crystal apparently makes it possible to eliminate the inhomogeneity of the working transition of the active centers.

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[1] Collins, Nelson, Schawlow, Bond, Garrett, and Kaizer, Phys. Rev. Lett. 5, 303 (1960).
[2] E. Snitzer, Phys. Rev. Lett. 7, 444 (1961).
[3] Tang, Statz, and deMars, J. Appl. Phys. 34, 2289 (1961).
[4] B. L. Livshitz and V. N. Tsikunov, DAN SSSR, in press.
[5] J. Free and A. Korpel, Proc. IEEE 52, 90 (1964).

1) There is only one published communication [5] concerning a laser with vibrating crystal, but it does not contain any proof of narrowing down of the spectrum of stimulated emission from the ruby.

2) The generation threshold ($V \sim 1700$ V, $C = 1000\ \mu$F) remains practically unchanged as the crystal moves.

CORRECTION

In the article by B. L. Livshitz et al. (JETP Letters v. 1, no. 5, Russian p. 23, translation p. 136, the captions of Figs. 1 and 2 have been interchanged. In addition, the letters "a" and "b" on the photographs of Fig. 1 have been interchanged.