SovietRxiv

Soviet-era science, translated into English

TIME DEPENDENCE OF STIMULATED EMISSION IN A RUBY LASER WITH SPHERICAL MIRRORS

![Fig. 1](image)

1964

SovietRxiv

View the original and related papers at https://sovietrxiv.org/items/ru-196401.65774

Source: Math-Net.Ru and CyberLeninka. Machine translation. Verify with the original.

SovietRxiv

Fig. 1

Figure 1: Fig. 1

Fig. 2

Figure 2: Fig. 2

Abstract

Full Text

T. N. ZUBAREV, A. K. SOKOLOV

TIME DEPENDENCE OF STIMULATED EMISSION IN A RUBY LASER WITH SPHERICAL MIRRORS

(Presented by Academician A. P. Aleksandrov, February 3, 1964)

As is known, the form of the time dependence of the stimulated emission of a ruby laser is determined to a considerable extent by the design of the optical resonator. In the case of a ruby laser with plane mirrors in the optical resonator, this dependence is, as a rule, an irregular oscillation ([1]). By contrast, in a laser with a ruby crystal in the form of a rectangular torus ([2]), and also in a ring laser ([3]), regular oscillations of the intensity of the stimulated emission are observed.

Fig. 1. Dependence of the intensity of stimulated emission on time for mirror spacings $L = 710$ mm (a), 800 mm (b), and 940 mm (c). $C = 600$ μF, $U = 5$ kV, generator frequency 100 kHz

Fig. 2. Dependence of the intensity of stimulated emission on time at voltages $U = 5$ kV (a) and 6 kV (b). $L = 800$ mm, $C = 300$ μF, generator frequency 50 kHz

The authors investigated the time dependence of the intensity of stimulated emission of a ruby laser in whose optical resonator opaque spherical mirrors with an aluminum coating were installed. The radius of curvature of the mirrors was 400 mm. The ruby crystal (diameter 12 mm, length 120 mm; chromium-ion concentration 0.05%) was placed on the middle part of the axis of the optical resonator, with the geometrical axis of the crystal coinciding with the axis of the resonator. As the pump lamp, a helical pulsed xenon lamp was used, with a maximum electrical flash energy of ~ 7.5 kJ at a flash duration of ~ 1 msec. The lamp was powered by a bank of capacitors of capacitance C equal to 300–1200 μF. The initial voltage U on the capacitors was varied within the range 2.5–6 kV. To measure the intensity of the stimulated emission of the laser, a vacuum photocell was used. The radiation was coupled out of the resonator by

SovietRxiv

Figure 3

Figure 3: Figure 3

Figure 4

Figure 4: Figure 4

means of a quartz plane-parallel plate set at an angle of $\sim 45^\circ$ to the resonator axis. The study was carried out at room temperature.

The form of the time dependence of the intensity of stimulated emission was determined for various values of the spacing between the mirrors L (Fig. 1). For $L \lesssim 2R$ (R is the radius of curvature of the mirrors), regular oscillations are, as a rule, observed in the time dependence of the intensity of stimulated emission. Increasing L to values $L > 2R$ gradually leads to the appearance of disruptions in the regular oscillations. With further

As L is increased, the change in the intensity of the stimulated emission with time becomes irregular.

In the absence of breakdowns in the regular oscillations ($L \lesssim 2R$), we investigated how the form of the dependence of the intensity of the stimulated emission on time changes when the pump-lamp power is varied (by changing the voltage on the capacitors).

Fig. 3. Dependence of the intensity of stimulated emission on time at voltages $U = 2.5$ kV (a), 3.5 kV (b), and 4 kV (c). $L = 800$ mm, $C = 1200$ μF, generator frequency 50 kHz.

The characteristic form of this dependence at a sufficiently high initial pump-lamp power is shown in Fig. 2. At the beginning of generation there is a transient period, characterized by regular damped oscillations of the stimulated-emission intensity about a certain intensity value corresponding to equilibrium at the given pump power ([4]). The duration of the transient period decreases as the initial pump-lamp power is increased. After the transient period, a quasi-stationary generation regime is established.

In this regime the intensity of the stimulated emission has a constant (more precisely, smoothly varying) component, which is modulated by regular undamped oscillations with a modulation depth of $\lesssim 10 \div 20\%$. The magnitude of the constant component decreases during the flash because of the gradual decrease in the intensity of the luminous flux of the pump lamp. The quasi-stationary regime is characterized by a monotonic decrease in the oscillation frequency and an increase in the modulation depth as the pump-lamp power decreases.

Fig. 4. Dependence of the intensity of stimulated emission on time at voltage $U = 5$ kV, $L = 800$ mm, $C = 600$ μF, generator frequency 50 kHz.

A different picture arises when the pump-lamp power is comparatively low (Fig.

SovietRxiv

3). In this case the stimulated emission is generated in the form of light pulses that follow regularly in time (undamped oscillations), while the constant component in its intensity is practically absent. The frequency of the undamped oscillations, as in the quasi-stationary regime, decreases as the pump power is reduced.

With a sufficiently long flash duration it is possible to observe, within a single generation event, the transition from the quasi-stationary generation regime to the regime of undamped oscillations with large amplitude, in the course of the decrease in the luminous flux of the pump lamp (Fig. 4).

Received
22 I 1964

REFERENCES

1. *Advances in Quantum Electronics*, N. Y.—London, 1961.
2. P. Walsh, G. Kemeny, *J. Appl. Phys.*, **34**, 956 (1963).
3. C. L. Tang, H. Statz, G. deMars, *Appl. Phys. Lett.*, **2**, 222 (1963).
4. A. K. Sokolov, T. N. Zubarev, *Fiz. tverd. tela*, **9**, 2590 (1964).

Note: Figure translations are in progress. See original paper for figures.

Source: Math-Net.Ru and CyberLeninka. Machine translation. Verify with the original.