to the local fields at the Fe^{3+} ion in the sublattices are equal in this case, and a single line is observed as a result.

In the course of the reorientation, the easy axis is symmetrically split into two directions at angles $\pm\theta$ to the c axis. In this case the equivalence of the Fe^{3+} ions is violated, i.e., the anisotropic contributions to the local field have different signs, and this lead to splitting of the resonant line into two lines of equal intensity.

The order of magnitude of the splitting does not contradict this assumption.

The results confirm the continuity of the change of the angle θ and are evidence favoring the second-order phase transition.

The reorientation temperature range determined by us (83 - 98°K) agrees satisfactorily with the data of [1] (81.5 - 94°K), obtained by the magnetic-torsion method. The small discrepancy in the size of the interval can be attributed to the fact that our measurements are free of the influence of an external magnetic field.

The absence of anomalies in the temperature dependence of the effective magnetic fields at the Fe^{57} nuclei in the orthoferrite $SmFeO_3$ in the reorientation region, noted in [4], may be connected with the lower resolution of the Mossbauer spectroscopy.

A calculation of the anisotropy of the dipole field and of the hyperfine interaction make it possible to determine from the presented data the temperature dependence of the angle θ. These data will be published later.

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SINGLE-FREQUENCY BRILLOUIN LASER USING METHANE

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In all the presently known Brillouin lasers (see [1]) the active media employed are different liquids. In many cases, however, it is preferable to use compressed gases, owing to the higher self-focusing threshold and the better optical quality [2]. On the other hand, a study of the operation of such lasers is usually greatly hindered by processes of successive scattering in the resonator, which lead to the appearance of several lines in the emission

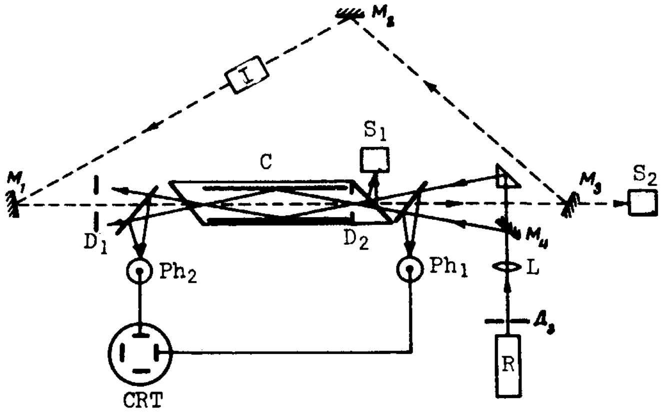

Fig. 1. Experimental setup: C - cell with methane; I - optical isolator; M_1, M_2, M_3, M_4 - dielectric mirrors with transmissions 2, 2, 40 and 50% respectively at λ = 0.6943 μ (M_1 - spherical with R = 160 m, M_2, M_3, M_4 - flat); R - ruby laser, beam diameter ∿3 mm; D_1 and D_2 - diaphragms 5 × 5 mm; D_3 - diaphragm 3 × 3 mm; L - lens with focal length 37 cm; Ph_1 and Ph_2 - FEK-09 coaxial photocells; CRT - cathode-ray tube of I2-7 oscilloscope; S_1 and S_2 - systems for the measurement of the pump and generation radiation parameters.

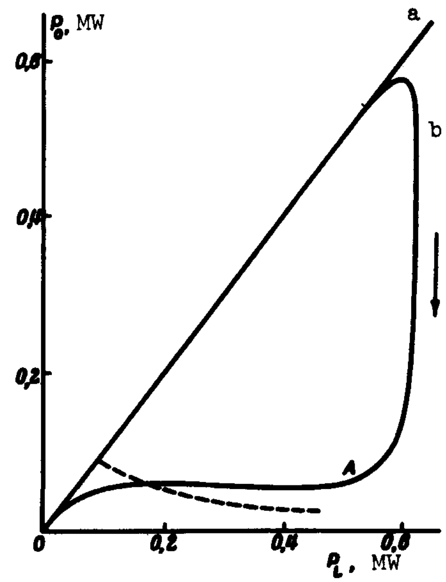

Fig. 2. Experimental oscillograms: a - in the absence of a resonator, b - with a rasonator. Dashed - theoretical curve.

spectrum. We report here, for the first time, the development of a single-frequency Brillouin gas laser.

The active medium of this laser is methane at room temperature and a pressure of 130 atm[1]. We used a ring resonator with an optical isolator based on a Faraday cell [3]. In such a system, the radiation can propagate only in one direction, and consequently generation due to successive scattering through 180° is impossible. The resonator was made up of mirrors M_1, M_2, and M_3, and its optical length was 6.6 m.

The pump radiation from a ruby laser was split with the aid of mirror M_4 into two beams of equal intensity (the angle between them was ∿1°). These beams fell into a hollow-glass light pipe placed in a cell with methane, was reflected several times from its walls, and emerged from the cell. The light pipe had a square cross section 6 × 6 mm and a length 0.95 m, while the cell length was 0.96 m. The angles between the walls of the light pipe and the pump beam were about 0.5°. At such small angles the coefficient of reflection from the glass is close to unity, and therefore the pump intensity is practically constant over the entire cell length in the absence of generation. To prevent generation due to reflections from the light pipe, diaphragms D_1 and D_2 were placed in the resonator, and the cell windows were inclined 45°.

The lens L produces in the plane of the diaphragm D_2 the image of the diaphragm D_3. The dimension of the image is equal to that of the diaphragm D_2. The measuring apparatus S_1 registers therefore only the radiation that enters the light pipe.

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[1] Under these conditions the gain due to the SMBS is g ∿ 0.09 cm/MW, and the width of the gain line is ∿20 MHz [4].

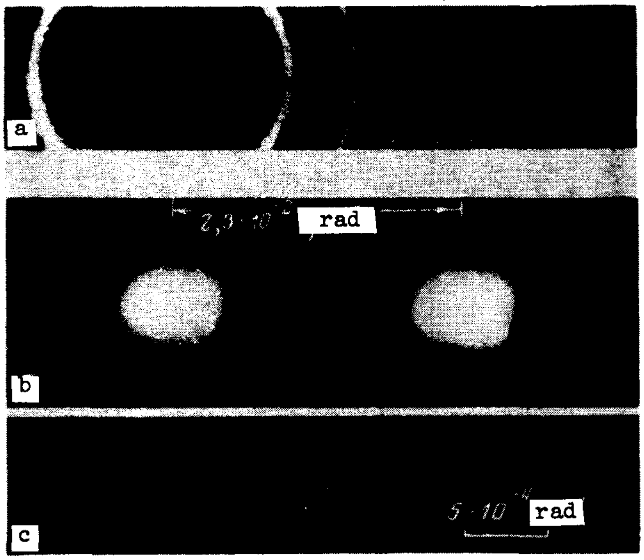

Fig. 3. Characteristics of generation and pump radiation: a - spectrogram of generation radiation (Fabry-Perot inter ferometer dispersion 3.33×10^{-2} cm^{-1}); b - distribution of the pump radiation in the far zone (the two spots correspond to two pump beams); c - the same for the generation radiation.

The ruby laser operates on a single axial mode, and its radiation on entering the cell has a maximum power ~0.6 MW at a pulse duration about 200 psec at half-height. The divergence of each beam is $\sim 5 \times 10^{-3}$ rad. The pump parameters satisfy the conditions for an increase in the radiation brightness [1].

The photocells Ph_1 and Ph_2 register the pump light at the entry and emergence from the cell, respectively. The signals from these photocells are fed simultaneously to the horizontal and vertical deflection systems of the cathode ray tube. As a result, the tube screen displays the dependence of the power of the radiation passing through the cell (P_0) on the pump power entering the cell (P_L). When a Brillouin laser operates in the quasistationary regime, the equality $P_0 = P_L - P_B$ should be satisfied, where P_B is the power of the generated radiation.

In the absence of a resonator, no nonlinear processes develop in the methane, so that P_0 is linear in P_L (Fig. 2a). The oscillogram obtained in the presence of the resonator is shown in Fig. 2b; the direction of the electron-beam motion is indicated by the arrow. The ambiguity of the curve is due to the fact that a transient generation regime is observed at the start of the pump pulse (up to A), and the regime is close to stationary at the end of the pulse (beyond A).

In the stationary case, the interaction of the pump and generation radiation in the active medium of our laser is described approximately by the equations [5]

$$\frac{dI}{dx} = g\,I(x)J(x), \tag{1}$$

$$\frac{dJ}{dx} = g\,I(x)\,J(x), \tag{2}$$

where I and J are the intensity of the pump and generation, respectively; the generation radiation propagates in the +x direction ($0 \leq x \leq L$). In the stationary regime there should be satisfied the usual condition

$$\frac{J(L)}{J(0)} = K, \tag{3}$$

where J(L)/J(0) is the gain in the cell and K is the attenuation of the light in the resonator (I < K < ∞). The simultaneous solution of (1), (2), and (3) can be written in parametric form:

$$I(L) = \frac{1}{gL}\left(\frac{K-1}{K\gamma - 1}\right)\ln K\gamma \text{ and } I(0) = \gamma I(L), \tag{4}$$

where the parameter γ varies in the range $0 < \gamma \leq 1$.

In our laser K ∿ 7. The dashed curve of Fig. 2 was plotted for this value of K using formulas (4), the intensities I(L) and I(0) having been converted into the corresponding powers P_L and P_0. The differences between the experimental curve (beyond A) and the calculated one is apparently due to the fact that the duration of the pump pulse is insufficient to establish a quasistationary generation regime. It should also be recognized that Eqs. (1) and (2) have been derived only for the case of plane pump and generation waves.

It is seen from Fig. 2b that an appreciable fraction of the pump power is transformed into the radiation of the Brillouin laser. This fraction reaches 88%. At the same time, the radiation power at the laser output does not exceed ∿35% of P_L, owing to the large resonator losses. A reduction of the losses (which is quite feasible) can result, of course, in a higher efficiency.

The laser operates at a single axial mode. A single line is observed in the spectrum of the generated radiation (Fig. 3a); no generation due to secondary scattering through 180° was observed. Figures 3b and 3c show for comparison photographs of the distribution of the radiation in the far zone for the pump and for the generation. The divergence of the generated beam is practically equal to the diffraction value $\sim 1.2 \times 10^{-4}$ rad. (The measurements were performed in the same manner as in [1].) An estimate shows that the brightness of the radiation emerging from the laser is approximately 700 times larger than the pump-radiation brightness.

We have thus demonstrated the feasibility of single-frequency generation with a large increase of the brightness in a Brillouin gas laser.

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