amplification due to optical pumping. We note that the populations of the sublevels of the ground state of OH are very sensitive to the form of the spectrum of the optical radiation, and this is in part due to the fact that several spectral lines practically coincide with the resonant frequencies of OH. (For example, the λ = 3063 Å line of NII coincides with the resonant transition ${}^2\Sigma^+_{v=0,k=3,J=5/2} \rightarrow {}^2\Pi_{3/2\ v=0,k=1,J=3/2}$.)

Coherent amplification of cosmic radio emission must be expected primarily in regions directly adjacent to the ionization zone of hot stars.

The difference between such a natural cosmic maser and the laboratory device lies primarily in the fact that in astrophysical systems there are no reflectors or resonators, and no standing waves are set up. Essentially these are coherent traveling-wave amplifiers. The amplification of the radiation is not the result of multiple passage of the ray through the same bounded volume of gas, but the result of the giant dimensions of the amplifying system. In the laboratory device, the presence of resonators and reflectors leads to appreciable loss of radiation energy. Under astrophysical conditions there is no such loss. Therefore even a small degree of population inversion turns out to be sufficient for effective amplification.

Thus, in the stationary amplification mode, part of the energy of the optical band will be continuously transformed into radio-emission energy. A particularly large amplification effect can be observed in nova and supernova flares. In this case the excitation energy accumulated by the atoms and molecules can be released in the form of a brief but very intense burst of radio emission. This phenomenon could be observed by comparing curves characterizing the time variation of the intensity of the optical and radio emissions during the initial stage of the flare.

The foregoing gives grounds for assuming that coherent amplification of radiation is a widespread phenomenon in the Universe.

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GIANT SUPERLUMINESCENCE PULSES

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1. The giant pulses of coherent light emitted by Q-switched lasers are widely known [1-3]. For research in nonlinear optics, or for investigations of the mechanism of damage to transparent materials by a strong light field, it is of interest also to employ sources of

giant pulses of incoherent light, since experiments with giant pulses of coherent and incoherent light can disclose the role of coherence and the role of optical power in the case of interaction with matter.

In this letter we report a study of giant pulses of superluminescence of a strongly excited active neodymium-glass medium with rapid switching of the gain.

2. Superluminescence is enhanced spontaneous radiation from an active medium. In long rods of an active medium with large gain per pass, the luminescent radiation becomes directed and the duration τ_p of the superluminescence pulse is usually much shorter than the time T_1 of the spontaneous decay of the excited particles, but many times longer than the time T_0 necessary for the photon to traverse the active medium [4]. However, if a large gain K is produced instantaneously in a medium, such that the spontaneous photons are amplified in one pass sufficiently for most active particles to radiate, then it is possible to obtain the very short superluminescence pulses of duration on the order of T_0. The condition for obtaining such extremely short pulses is

$$K \frac{T_0}{T_1} \frac{N_{20}}{N_0} \frac{\Omega_{\text{eff}}}{2\pi} > 1, \tag{1}$$

where N_0 and N_{20} are the initial inverse population and the population of the upper working level, respectively; Ω_{eff} is the effective solid angle of the superluminescence and is determined by the geometry of the medium. At the threshold of satisfaction of condition (1), the radiated pulse has a duration on the order of several times T_0, but if this condition is overfulfilled, then τ_p tends to T_0.

Fig. 1. Diagram of setup for obtaining and recording giant superluminescence pulses. 1 - Dense mirror, 2 - Kerr shutter, 3 - neodymium-glass rods, 4 - filter, 5 - coaxial photocell.

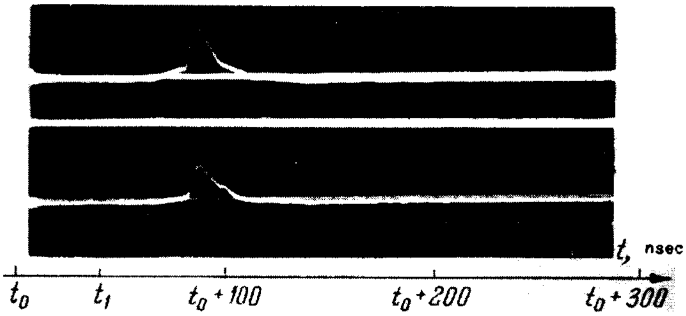

Fig. 2. Oscillograms of giant superluminescence pulses.

3. A diagram of the setup is shown in Fig. 1. The active medium consists of two identical neodymium-glass rods (KGSS-7) of 10 mm diameter, with matte lateral surfaces and with butt ends cut at the Brewster angle. The pump lamps illuminated 900 mm of the lateral surface of the rods. The gain in the two pumped rods was of the order of 10^4 per pass. The gain was instantaneously increased to 10^8 by uncovering the dense mirror with a Kerr shutter. The time necessary for the photon to traverse the active medium (with reflection from the mirror) was $T_0 = 16$ nsec, and the measured solid angle $\Omega_{\text{eff}} \simeq 10^{-2}$ sr. For the Nd^{3+} ion in the glass,

$T_1 \approx 5 \times 10^{-4}$ sec, and the lower working level $^4I_{11/2}$ is short lived, so that $N_{20} \approx N_0$. After opening the shutter, the gain of the medium K reaches 10^8 per pass, and consequently condition (1) is satisfied in our apparatus.

Figure 2 shows pulses radiated by the medium at $K \approx 10^8$. The pulse energy was approximately 4 J. The pulse duration at half-maximum was 9 - 12 nsec, and the start of the pulses lagged behind the time of gain switching t_1 by 25 - 30 nsec. The medium is thus de-excited within less than three passes, the main energy being radiated within a time shorter than T_0.

4. The maximum gain of the active medium with the Kerr shutter closed is limited by the self-excitation of the pumped glass rods due to Fresnel reflection of the light, polarized perpendicular to the plane of incidence from the butt end with the Brewster angle, on the lateral matte surface, and subsequent scattering (with depolarization of the radiation) in the backward direction. Inasmuch as the gain of the neodymium glass, unlike ruby, does not depend on the polarization of the light, this leads to a feedback coefficient $\rho \sim (n^2 - 1)^2\Omega_{eff}/2(n^2 + 1)^2 2\pi \approx 10^{-4}$ (n is the refractive index of the glass), and to a limiting gain of the order of $\rho^{-1} \approx 10^4$, which agrees with experiment.

5. The power of the obtained superluminescence pulses reached 500 mW/cm^2. Several intense flashes damaged the output end of the rod at the point A (Fig. 1). Thus, self-damage of neodymium glass is possible under the influence of intense incoherent radiation.

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MAGNETOSTRICTION OF RARE-EARTH GALLATE GARNETS

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Tremendous magnetostriction is observed in terbium, dysprosium, and holmium iron garnets at helium temperatures [1], whereas in yttrium and gadolinium iron garnets the magnetostriction is very small. According to modern notions, the large magnetostriction effects in these ferrimagnets are due to the influence of the orbital state of the Tb^{3+}, Dy^{3+}, and Ho^{3+} ions on the crystal lattice.

We investigated the magnetostriction of paramagnetic garnets in which all the iron was replaced by diamagnetic gallium. Iron and gallium garnets have very similar structures [2], and it can therefore be assumed that the investigation of the gallates yields additional in-