At angles $\theta \lesssim 2\sqrt{m_e/m_i}$ (i.e., earlier than in the case of $\theta \ll \sqrt{m_e/m_i}$), dispersion due to electron inertia predominates, as indicated by the lagging oscillatory train and by $\delta \sim c/\omega_0$ [1] (Fig. 2c). The deviation from the stationary form of the normal wave is associated with cumulation [5].

The foregoing results agree with the numerical solution obtained in [7] if the general parameter is chosen to be $\theta/\sqrt{m_e/m_i}$.

The registration of H_φ makes it possible to establish more precisely the mechanism shaping the width of the discontinuity at small angles. It turns out that even after the vanishing of the leading oscillation, a dispersion contribution with $\delta \sim \theta(c/\Omega_0)$ remains, as is evidenced by the H_φ perturbations localized in the vicinity of the main discontinuity (Figs. 3c, d). Predominating in the "normal" wave are the lagging hf oscillations of H_φ, with $\delta \sim c/\omega_0$; as $\theta \to 0$ we have $H_\varphi \to 0$ (Figs. 3e, f, g).

The development of small-scale instabilities at $n_0 \sim 10^{13}$ cm^{-3} "smears out" the oscillations with $\delta \sim c/\omega_0$, but the effective skin depth $\delta_s \sim 10(c/\omega_0)$ [4] does not prevent the formation of "oblique" oscillations, since $[(c/\Omega)/\theta]/\delta_s \gtrsim 1$ even when $\theta \gtrsim 10\sqrt{m_e/m_i}$. In such a mode, with $\theta \to 0$, we observed a transition to an aperiodic profile (the plasma turbulence was determined independently from the noise emission and scattering of an external beam of electromagnetic waves). A Joule dissipation effect comparable with the effect of the dispersion ($\theta \gg \sqrt{m_e/m_i}$) was observed only at very low degrees of ionization ($p_0 \sim 10^{-2} - 10^{-1}$ mm Hg, $n_0 \sim 10^{13}$ cm^{-3}).

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SHAPE OF WAVE FRONT AND SPATIAL EMISSION COHERENCE IN A RUBY LASER GIANT PULSE

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The shape of the wave front and the spatial coherence have been thoroughly investigated experimentally for lasers in the free mode, but no such research was carried out for the giant-pulse mode.

We have investigated the spatial coherence and the shape of the emission wave front of a giant pulse from a ruby laser with a Pockels-cell shutter. The shutter consisted of a KDP crystal and a polarizer comprising a stack of glass plates placed between a flat mirror with 98% reflection coefficient and a ruby crystal 120 mm long and 11.6 mm in diameter. The second mirror, located 70 cm away from the first, a 30% reflection coefficient. The energy of the giant pulse was 0.1 - 1 J, the total duration was 30 - 50 nsec.

As is well known (see [4]), the spatial coherence of two points of the wave field is determined from the contrast of the interference fringes obtained by Fraunhofer diffraction from two apertures (the Young scheme). Integral photographs obtained with the aid of such a scheme during the time of one giant pulse have shown that the interference fringes were strongly smeared. This means that the spatial coherence is not conserved during the time of the entire pulse, i.e., the relative phases and amplitudes at the investigated two points change. In other words, the shape of the wave front changes.

To measure the shape of the wave front, we used Linnik's interferometer scheme, in which it is possible to obtain information on the entire wave front at once, and not only on the relative phases of two points, as in Young's scheme. In this scheme a glass plate with a partly transmitting aluminum coating was placed directly behind the laser mirror. The plate had an opening of 0.3 mm diameter. The generated emission, after passing through the coating, interfered with the spherical ("reference") wave obtained as a result of diffraction by the opening. The interference pattern consisted of fringes of equal height of the investigated wave front, relative to the spherical reference wave. It was obtained in sharpest form at a distance of 148 cm, as checked with the aid of a gas laser. (A similar scheme was used in [3] to study the wave front under free laser generation.) The integral photographs obtained in one giant pulse (Fig. 1) show elongated blurred rings.

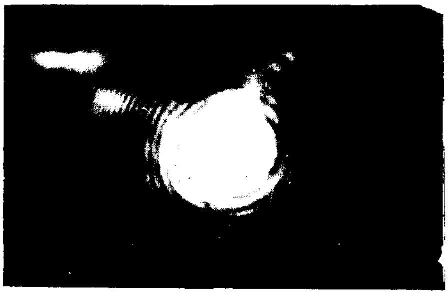

Fig. 1. Interference pattern of the radiation front of a giant pulse, obtained by Linnik's scheme. The pump energy exceeds the threshold by 10%.

The evolution of the wave front was investigated with the aid of an electron-optical converter (EOC) operating in the slit-scanning mode, with a time resolution 0.5 nsec (the same as in [5]). The interference pattern, which consisted of rings, was projected on the EOC slit, so that the slit passed through the center of the pattern.

Figure 2 shows examples of such sweeps at different pump energies. From the spacing of the fringes, using the formulas given in [3], we could calculate the distance from the center of curvature of the laser-emission wave front to the front mirror of the laser. Its average value was 230 ± 20 cm.* The displacement of the pattern with time represents the variation of the wave front in the plane of the slit. During the first 10 - 15 nsec, when the "spreading" of the generation field takes place [5], only a smooth displacement of the fringes is usually observed, without abrupt jumps. In some cases the entire fringe system shifts upwards or downwards (e.g., Fig. 2a), and in others the central fringe decreases in size (Fig. 2b) with practically no change in the sizes of the peripheral fringes. This in-

Fig. 2. Time sweeps of the interference patterns of a giant-pulse radiation front at different values of the pump energy E_{pump} over the threshold energy E_{thr}: a - E_{pump}/E_{thr} = 1.1, b - E_{pump}/E_{thr} = 1.1, c - E_{pump}/E_{thr} = 1.3, d - E_{pump}/E_{thr} = 1.8. The modulation of the intensity seen in the photographs is due to beats between modes having different axial indices.

dicates a change in the slope of the wave front respectively in the vertical or horizontal plane, without a change in the curvature radius of the front. This change in slope reaches a value 2.5', which agrees with the direction changes obtained during the evolution of the giant pulse in the earlier work [6]. After the spreading of the field stops, the fringes change in a jumpwise fashion, the changes occurring on the average every 3 - 4 nsec. Such a picture is attributed to jumplike redistributions of the phase on the wave front and to the change in the slope of the front. The curvature radius of the front does not change here by more than ±20 cm. With increase in pump energy, the number of jumps increases. The dependence of the average number of jumps on the pumping is shown in the table.

T a b l e

Dependence of average number $\bar{n}$ of phase jumps on the pump-to-threshold energy ratio E_{pump}/E_{thr}. $\bar{n}$ was caluclated by averaging the number of jumps n over all photographs taken at the given pump energy

E_{pump}/E_{thr}	$\bar{n}$
1.10	2.8 ± 0.1
1.25	3.7 ± 0.1
1.30	3.9 ± 0.2
1.50	4.7 ± 0.2
1.80	7 ± 1
1.95	6.3 ± 0.5

Thus, the shape of the generation wave front does not remain constant during the giant pulse. During the time of development of the generation field, the front slope varies smoothly in one direction. This change in the front slope can be explained by using the theory of development of the giant-pulse generation [6]. On the other hand, according to the theory in [6], there should be no phase jumps or slope changes after the end of the field development. This may be explained by recognizing that the theory in [6] was developed for resonators that are plane-parallel or nearly so, whereas the laser cavity is not plane-parallel in practice, owing to inhomogeneities in the ruby crystal. It is possible that the most important role is played here by minute knot-like inhomogeneities, and not the general "lenticular" behavior of the crystal considered in [6].

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* This quantity was obtained for one crystal and probably depends on the inhomogeneities of the ruby samples.

ERRATUM

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Figure 2 should read "20 nsec" in lieu of "20 msec."