$\lambda(z) \sim (z_0 - z)^{2/3}$, where z_0 is the point of singularity. The power concentrated in the singularity is equal to the critical value:

$$\int |\Psi|^2 dr = 2\pi \int_0^\infty R^2 r\, dr \sim 1.86.$$

Near the singularity it is necessary to take into account the influence of factors that were not taken into account in the derivation of (1). In a conservative medium with purely cubic nonlinearity, the first to come into play is violation of the quasioptical approximation. This leads to the appearance of a backward wave reflected from the focus. A similar effect (but with change of frequency) is obtained when account is taken of stimulated Raman scattering. Some influence on the behavior near the focus can be exerted by the vector structures of the electromagnetic field, namely the appearance of its longitudinal component. The cases most investigated, however, are those in which the field at the focus is limited either by nonlinear damping or by saturation of the nonlinearity. Nonlinear damping (two-photon or higher) of the energy leads to absorption of the energy that enters in the focus. For intense beams this produces the sequence of foci first described in[7]. Quasi-stationary variation of the beam amplitude at the entrance to the medium gives rise to motion of the foci[8].

If the nonlinearity is saturated (deviates from cubic), the diffraction effects turn out to be stronger than the nonlinear-focusing effects, and the dimension of the focus is finite. However, the rays emerging from the focus are again gathered into a focus some distance away, so that a pulsating waveguide is produced[6b]. Several randomly oscillating waveguides can be produced if the initial-beam power is high enough.

From the point of view of experimental observation, the picture of oscillating waveguides and the picture of absorbing foci are difficult to distinguish, and their identification calls for organization of special experiments. It is probable, however, that absorption foci are produced when light propagates in Kerr-type dielectrics; the waveguides should be observed in the case of self-focusing in a plasma.

Notice should also be taken of the role of nonstationary processes of nonlinearity relaxation and of parametric four-photon instability. Whereas these processes are negligible for long pulses ($\tau \sim 10^{-9}$ sec), they may become decisive for short pulses ($\tau \sim 10^{-11}-10^{-12}$ sec).

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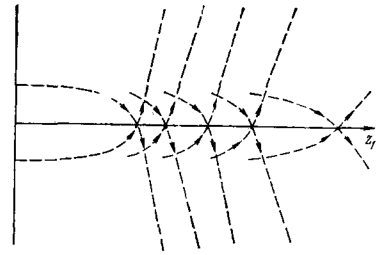
V. N. Lugovoĭ. Theory of Propagation of Giant Laser Pulses in a Nonlinear Medium. The propagation of intense light beams in nonlinear media has recently attracted much attention. The greatest interest attaches to light beams obtained in pulsed lasers, in which the main contribution to the nonlinearity of the medium is made by the Kerr effect. Consequently, most papers dealing with the propagation of light in nonlinear media, following the first (1964) paper of Chiao, Garmire, and Townes[1], deal with a Kerr-type nonlinearity, where the refractive index of the medium is a function of the light intensity.

The concept of critical beam power was introduced in[1], and it was subsequently shown by Kelley in 1965[2] that a light beam with above-critical power begins to propagate in a medium with Kerr nonlinearity in the following manner. The intensity on the axis of this beam increases without limit (within the framework of the employed parabolic equation) when it approaches a certain point on the axis (the "collapse" point). The propagation of the beam beyond the collapse point, however, was not considered. The point of view commonly accepted at that time was that self-trapping of the beam in the waveguide-propagation regime takes place beyond the collapse point[1] (the beam-intensity profile in the waveguide regime in a Kerr medium was calculated in[1]). The experimentally observed thin luminous filaments in liquids, glasses, and subsequently also in gases were regarded as realization of such a regime. We note that the possibility of self-trapping of an electromagnetic beam in the waveguide regime was noted back in 1958 by Volkov[3], who was the first to calculate the beam intensity profile in the case of self-trapping in a plasma. Subsequently, such a possibility was mentioned also in[4] (the intensity profile considered in[4b] coincides with that obtained in[3]).

Many experimental results, however, could not be explained by the hypothesis of self-trapping of the beam in the waveguide regime beyond the collapse point. In 1967 Dyshko, Lugovoĭ, and Prokhorov[5a] have proposed, on the basis of a numerical solution of the problem, a new (multifocus) picture of the propagation of light beam beyond this point in media with Kerr nonlinearity, and in 1968 Lugovoĭ and Prokhorov[6] explained the thin luminous filaments previously observed in experiment not as being due to waveguide propagation, but as trajectories of moving foci.

The multifocus structure of a light beam is a finite series of individual foci produced on the beam axis as a result of successive focusing of different annular zones of the beam. The multifocus structure is shown schematically in the figure. The collapse point itself



is not the start of the suggested waveguide filament, but the first focus. A detailed investigation[5b] of the influence of different types of nonlinear absorption in the medium (i.e., the imaginary part of the refractive index) on the picture of the beam propagation has shown that, independently of the concrete form of this absorption, a multifocus structure is produced. Recently Dyshko, Lugovoĭ, and Prokhorov investigated also the influence of deviations from a quadratic field dependence of the real part of the refractive index, which can be caused under real conditions by the so called "saturation" of the Kerr nonlinearity (see[7]) or by nonlinear absorption in the medium. Numerical calculations have shown not only that the multifocus structure is preserved qualitatively, but that the corrections to the parameters of the foci are small even quantitatively. Thus, for media with Kerr nonlinearity the multifocus picture of the propagation of light beams turned out to be quite universal, i.e., it should be observed under various physical conditions.

The indicated results pertain to a beam that is stationary in time. Under real conditions, however, the beam power varies with time in accordance with the envelope of the laser pulse. As shown by Lugovoĭ and Prokhorov[6], for giant laser pulses, i.e., pulses with duration on the order of 10^{-8} sec, the foci should move along the beam axis with velocities on the order of 10^9 cm/sec (under typical conditions). Superimposed photographs of the beam propagation, taken from the side, should show thin filaments that are the tracks of the motion of the foci. Thus, the filaments previously observed in the experiment were explained not as being due to waveguide propagation, but as trajectories of moving foci.

Simultaneously with the first experimental confirmations[8,9] of the moving-foci theory, this theory was further extended[8a,10] to include the case of so-called ultrashort laser pulses. It was shown there that the previously established picture of moving foci is retained in this case, too. The only difference lies in the character of the onset and motion of the foci. According to the theory, the velocity of the foci can greatly exceed in this case the velocity of light in vacuum, as was confirmed experimentally in[8b]. The multifocus structure in picosecond laser pulses (with duration $\sim 3 \times 10^{-12}$ sec) was also registered recently in experiments.

Many experimental results have by now been explained on the basis of the theory of moving foci.

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V. V. Korobkin. Experimental Investigation of the Propagation of Powerful Radiation in Nonlinear Media. One of the central problems of nonlinear optics is the investigation of the propagation of bounded light beams in nonlinear media, i.e., in media in which the refractive index n depends on the field intensity E of the propagating beam:

$$n = n_0 + \Delta n\,(E^2).$$

This problem has now a rather long history, but still remains timely.

Abundant experimental material on this problem has been accumulated by now. We note first the work of Hercher[1], who was the first to observe filament-like damage in glasses. He did not connect the formation of such faults with changes in the refractive index of the medium. The possibility of such a connection was indicated by Pilipetskiĭ and Rustamov[2], who observed the formation of long radiation "filaments" in liquids. Subsequently, Townes and co-workers[3] have shown experimentally that the change in the transverse distribution of the intensity in the wave beam as it propagates in the nonlinear medium is connected with a change of the refractive index. In 1966, Brewer and Lifsitz[4] reported[4] observation of so-called small-scale "filaments" with diameters up to several microns and with lifetime shorter than 10^{-9} sec. We note also the interesting work by Shimizu[5] and by Zverev and co-workers[6]. Initially, the predominant concept in nonlinear optics was that of waveguide propagation in media with $\Delta n > 0$, and the results of the first experiments were treated precisely from this point of view. This concept, however, could not explain all the experimental results, particularly the short lifetimes of the "filaments."

In 1967, Lugovoĭ and Prokhorov (see[8]) advanced the concept of multifocus structure. In accordance with this concept, a system of focal points is produced in the nonlinear medium during the course of propagation, and these foci move relative to the medium when the radiation power changes. The "filaments" observed in different experiments are indeed the results of such a displacement.

The subsequent experiments were aimed to a considerable degree at an explanation of the validity of one concept or another. Korobkin and Alcock[9] have observed moving foci, apparently for the first time, in an investigation of a laser spark in air.

Loy and Shen[10], in a study of the propagation of laser radiation in nonlinear liquids, have shown that the waveguide regime was not realized in their experi-