Such a picture was obtained for a stationary initial distribution. However, under real conditions the distribution of the beam in the initial plane is not stationary, since the power of the laser beam varies in time in accordance with the envelope of the laser pulse (usually giant pulse). As a result, the picture observed under real conditions is essentially different.[17] The main difference between this picture and the stationary one lies in the fact that the focal points move. They can stop only at individual instants of time. The spatial trajectories of the moving focal points are thin filaments directed along the beam axis. In the case of time-integrated experimental observation, the trajectories of the moving focal points should be received as self-focusing filaments.

Thus, the authors have advanced in their paper[17] a new point of view concerning the process of Kerr self-focusing, differing from the concept of waveguide propagation. In a subsequent paper,[18] the theory of focal points was extended to include the case when the laser beam passes first through a gathering lens before entering the investigated medium. In [19] there was also developed a theory of Kerr self-focusing of picosecond laser pulses and it was shown that for such pulses the picture of self-focusing is also characterized by moving focal points. It was established in [20] that the presence of an additional phenomenon of stimulated Raman scattering in self-focusing can influence the really attainable concentration of energy in focal points and their dimensions, without changing the picture of the self-focusing phenomenon itself.

Recently, special experiments were performed to solve the problem of whether waveguide propagation of light takes place in self focusing or whether moving focal points arise. Korobkin and Alcock[21] and Loy and Shen,[22] who worked with single-mode lasers (i.e., under conditions corresponding to the initial premises of the theory), have established that under these conditions one observes in self-focusing moving focal points, and not waveguide propagation of light.

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G. A. Askar'yan, V. B. Studenov, and I. L. Chistyĭ.

Thermal Self-focusing in a Beam with Decreasing Intensity Near the Axis ("Banana" Self-focusing).

In ordinary media (gases, liquids), the refractive index decreases upon heating, and therefore a powerful beam becomes defocused. It is shown in this paper that by special choice of the distribution of the beam intensity over the radius—by decreasing the intensity near the axis—it is possible to realize self-focusing of the main part of the beam in a medium in which a solid beam becomes defocused. Such self-focusing with loss of the edge zone of the beam ("peels") was called "banana" self focusing.

Experiments were performed on self-focusing of this type. A beam with an intensity dip was produced by placing a small screen on the axis for the beam (the screen was deposited on a glass plate), and the diffraction divergence as well as the intrinsic divergence smoothed out the sharpness of the intensity dip already at a distance on the order of 1 m. Lasers of two types were used—a pulsed solid-state laser without Q switching, and a cw gas laser.

In a beam from a ruby laser of energy 20 J, in a millisecond pulse, there was obtained external self focusing at a distance of 1 m from the cell 15 cm long, filled with water to which a slight amount of vitriol was added. The trace of the beam was photographed also on a film with a SFR camera. The film shows how the intensity dip gives way to the bright spot of the self-focused point of the beam (see ZhETF Pis. Red. **10**, 113 (1969) [JETP Lett. **10**, 71 (1969)].

Self-focusing inside a layer of liquid was investigated inside a cell of 1 m length. Figures 1a and b show the trace of the beam on a screen immersed in water with a slight amount of absorber: a) the energy of the light pulse attenuated with light filters (the absorbed energy was insufficient to observe self-focusing); b) at energy of 20 J (a bright spot is seen at the center).

To verify the influence of the thermal conductivity

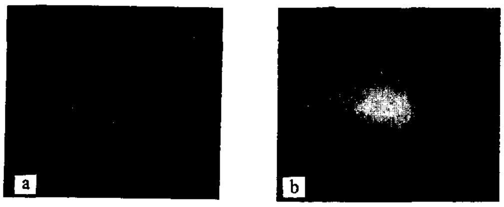

FIG. 1

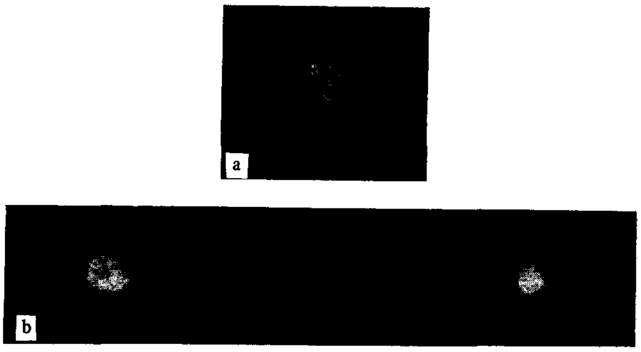

FIG. 2

and the convection on the self focusing, we used a cw argon laser of 0.3 W power. In the case of horizontal passage of a tubular beam through a cell with a liquid, deformation took place of the outer boundary of the beam, owing to convection, but this does not prevent formation of the bright spot of self-focusing (Fig. 2a). The time of establishment of the stationary picture was a fraction of a second. Figure 2b shows the trace of a beam passing vertically through the cell with the liquid; to the left of it is a control beam passing outside the cell.

The liquids investigated were methyl iodide, solution of iodine in alcohol, etc. Color film was used to investigate the dynamics of the process.

No self-focusing was produced when the cell with the liquid moved across the beam to one side or else in reciprocating motion at a velocity on the order of several centimeters per second.

The described experiments open up a possibility of controlling nonlinear optical effects by choosing the profile of the beam-intensity distribution. These effects can appear spontaneously in the presence of regions of decreased intensity in the laser beam, owing to the inhomogeneities of the generation power pumping, in the region of the shadow behind the absorbing or scattering centers in the medium, they can increase the intensity of the light on the beam axis when incident on a semi-infinite medium, etc.

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Yu. N. Barabanenkov, Yu. A. Kravtsov, S. M. Rytov, and V. I. Tatarskiĭ. Status of the Theory of Propagation of Waves in Randomly-inhomogeneous Media.

The investigation of wave propagation in randomly-inhomogeneous media has recently attracted more and more attention. The increased interest in this problem is due primarily to the large number of timely applied problems that have arisen in radiophysics, acoustics, optics, plasma theory, etc. The variety of these problems has stimulated the development of various methods for calculating the statistical parameters characterizing the wave field propagating in a randomly-inhomogeneous medium or passing through such a medium. The results obtained by these methods were partly summed in a number of monographs[1-5] and reviews,[6,7] but since the time of publication of these works, the statistical theory of scattering and propagation of waves has experienced definite changes.

First, new methods were developed for calculating the fluctuations of the wave field, for example the Markov approximation in the method of parabolic equation,[8-11] and procedures borrowed from other branches of physics, particularly methods of summing series of perturbation theory, analogous to those used in quantum electrodynamics,[3, 7, 12-14] have been developed. Second, "older" methods have been improved, making it possible to use them for the description of a larger group of phenomena than heretofore. Third, in many cases it became possible to refine the limits of applicability of different calculation methods, which, of course, contributed to the clarification of the entire picture.

In this review, the authors have attempted to give an idea of the existing methods of the theory of wave propagation in randomly-inhomogeneous media, the limits of their applicability, and the role of the recently developed new methods. The most clearly outlined are the limits of applicability of the theory of single scattering of waves (the Born approximation). It is suitable under conditions when the total intensity of the scattered field is small compared with the intensity of the incident wave. In many problems this condition is satisfied, making it possible to use all the advantages of the Born approximation, namely, to take into account the set of effects accompanying the scattering under complicated conditions (the presence of regular refraction, anisotropy of the medium, the pulse character of the scattered signal, etc.). It is important that the Born approximation is applicable to scattering both by small inhomogeneities (compared with the wavelength) and by large ones, but when the dimensions of the inhomogeneities are increased the region of applicability of this approximation decreases.

In contrast, the method of smooth perturbations (MSP for short) and the related method of geometrical optics are suited for the description of fluctuations of the wave field precisely in media with large-scale inhomogeneities. The question of the limits of applicability of the MSP has been discussed many times in the literature. At the present time it can be regarded as established that for media whose parameter fluctuations are characterized by a single scale, the first approximation of the MSP (just as the Born approximation) is suitable only at sufficiently small fluctuations of the phase of the wave and its level (the logarithm of the amplitude). On the other hand, if there is an entire spectrum of scales, and the large inhomogeneities are most strongly represented (as is the case, e.g., in the turbulent atmosphere), then the first MSP approximation is suitable up to mean-square fluctuations of the level of the order of unity, and the results concerning the fluc-