sec, then the focusing action could encompass the entire beam. Let us note that the condition of "weakness" of absorption, $\ell_\nu = 1/\kappa_\nu \gg z_f$, is satisfied in this example.

Bespalov and Talanov [4] have shown that at $\epsilon_2 E^2 > 0$ a plane wave with large supercritical power is unstable and breaks up into self-focusing beams. It is easy to see that absorption, to the contrary, stabilizes the wave. After the passage of a time sufficient for $|\delta\epsilon_{th}|$ to increase to $\delta\epsilon_{str}$ and $\Delta\epsilon_{Kerr}$, the thermal effect will suppress the spontaneously arising instability.

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1) In air under normal conditions $\Gamma = 0.4$ and $\rho(\partial\epsilon/\partial\rho) = \epsilon_0 - 1 \approx 6 \times 10^{-4}$. Absorption is connected with the presence of water vapor. For a typical value $\kappa_\nu \approx 0.03$ km^{-1} we get $|\Delta\epsilon_{th}| > \Delta\epsilon_{str}$ after $t' \approx 10^{-7}$ sec.

BREAKDOWN AT OPTICAL FREQUENCIES IN THE PRESENCE OF DIFFUSION LOSSES

V. E. Mitsuk, V. I. Savoskin, and V. A. Chernikov
Physics Department, Moscow State University
Submitted 31 May 1966
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The values of the threshold electric field intensity in a light wave, measured in experiments on optical breakdown of gases [1], are in good agreement with the theory of Ya. B. Zel'dovich and Yu. P. Raizer [2], which explains the primary breakdown on the basis of the electron-avalanche concept. No account is taken here of the electron losses during the avalanche development stage, an assumption justified for relatively high gas pressures (1 - 100 atm).

At lower gas pressures, the loss of electrons by diffusion from the focusing volume has an appreciable influence on the time constant of avalanche development, and consequently on the threshold electric field intensity in the light wave.

We present in this communication results of experiments on breakdown in krypton and xenon at optical frequencies and low pressures. In order to clarify the role of diffusion during breakdown, we varied the size of the focusing volume.

We used a ruby laser operating in the single-pulse mode, using a bleaching filter with phthalocyanine solution. The pulse duration was 60 nsec, and the energy of the single pulse of the order of 0.5 J. The beam divergence is estimated at 5'. The foregoing laser parameters were measured directly during the time of the experiment. Lenses corrected for aberration focused the laser beam inside a glass vacuum chamber containing the investigated gas at a fixed pressure. The occurrence of the discharge was monitored visually and by a photoelectric method based on the appearance of the spectral lines of the investigated gas in the emission spectrum of the light spark.

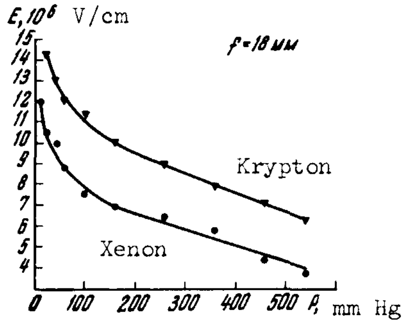

Fig. 1

The pressure dependence of the light-wave threshold electric field intensity in krypton and xenon, obtained with a lens of 18 mm focal distance is shown in Fig. 1. The experimental dependence on the pressure and on the type of gas is in good qualitative agreement with calculations based on the avalanche theory without account of losses. However, a quantitative comparison of theory and experiment shows that the experimental values of the threshold electric-field intensity lie higher than the theoretical ones in the entire region of the investigated pressures, the difference increasing with decreasing pressure; this can apparently be attributed to the increase in the role of diffusion loss with decreasing pressure.

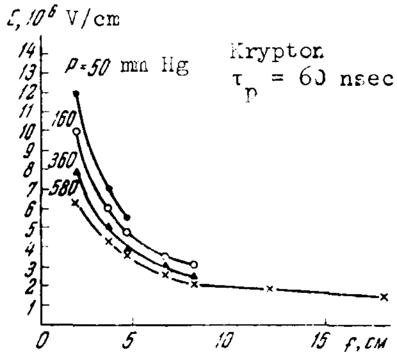

Fig. 2

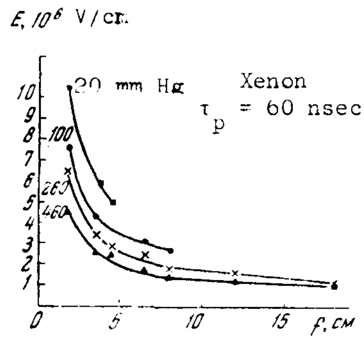

Fig. 3

To obtain more details on the role of the diffusion losses, we measured the threshold field intensity with focusing lenses having different focal distances (from 18 to 180 mm). We measured the diffusion length of the focusing volume and the diffusion lifetime of the electrons as functions of the focal distance even at fixed pressure. The results are shown in Fig. 2 (krypton) and in Fig. 3 (xenon). The curves show that the threshold field intensity depends strongly on the focal distance. At a fixed pressure, the threshold intensity increases sharply with increasing focal distance, especially in the region of low pressures and small focal distances.

The results of the experiments show conclusively that in breakdown at optical frequencies, at pressures below atmospheric, diffusion electron losses play an important role during the stage of development of the electron avalanche, and lead to an increase of the threshold field intensity. Other types of losses (recombination and elastic losses), according to estimates, are insignificant under these conditions.

In the presence of diffusion losses, the time constant θ' for avalanche development increases in accordance with the relation

$$\frac{1}{\theta'} = \frac{1}{\theta} - \frac{1}{\tau_D},$$

where θ is the time constant for avalanche development in the absence of losses and τ_D is the diffusion time ($\tau_D = \Lambda^2/D \sim f^2/D$, where Λ is the diffusion length and D is the diffusion coefficient).

Quantitative allowance for the diffusion losses, made under the assumption that the diffusion of the electrons from the focusing volume is free and that an important role is played in the investigated gases by slow-electron diffusion due to the Ramsauer effect, gives good agreement between the experimental results and the avalanche theory.

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NONLINEAR EFFECTS IN A HYPERSONIC WAVE

A. L. Polyakova
Acoustics Institute
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When a light wave produced by a giant laser pulse is focused inside a quartz single crystal, a hypersonic wave builds up [1]. Estimates show that in such experiments the intensity of the sound wave is quite appreciable, and consequently an important role in its propagation should be played by nonlinear phenomena. Nonlinear phenomena lead to a distortion of the wave form, to the appearance of higher harmonics, and in the case of sufficiently large intensities to the formation of a periodic shock wave.

This nonlinear-distortion process is counteracted by energy dissipation, which leads to a spreading of the steep shock fronts. To characterize the degree of nonlinear distortion in a sound wave we can introduce the dimensionless parameter [2]

$$R = \frac{\epsilon p}{\eta_{eff}\omega}, \tag{1}$$

where p and ω are the amplitude of the pressure and the frequency of the sound wave, ϵ a nonlinear parameter of the medium, of the order 4 - 5 for solids, and η_{eff} a certain effective "viscosity" of the medium, which determines the dissipation of the sound energy. If $R \ll 1$, then the dissipation prevails over the nonlinearity and the sound wave behaves essentially