a worse agreement between the physical ($h_2^2 \simeq 9$ dB) and the computer ($h_2^2 \simeq 6$ dB) experiments.

The physical and computer experiments have shown that the second threshold can be revealed also by some indirect attributes, for example, by the characteristic distortion of the top of the pump pulse and by the kink on the plot of the real susceptibility χ' against the pump power. It can therefore be assumed that the series of successive thresholds, first deduced by Petrakovskii and Berzhanskii from the distortion of the pump pulse [3], is connected with a stage-by-stage excitation of parametric spin waves.

Figure 3 illustrates the fact that the production of the second group of waves exerts a strong influence on χ', which goes through a maximum as a result, whereas in the model of one pair it increases monotonically. The imaginary part χ'' of the susceptibility hardly senses the second threshold.

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EFFECT OF A 400-kOe MAGNETIC FIELD ON A LASER-SPARK PLASMA

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We have previously observed [1] an increase in the intensity of the glow of a laser spark in a magnetic field H = 200 kOe. No change in the spark geometry was observed in that case.

The possibility of active action of a magnetic field on the geometry of a laser spark is connected, in our opinion, with the need for simultaneously satisfying two conditions: the magnetic pressure must be higher than the gas-kinetic pressure of the plasma, and consequently the relation between the field and the plasma temperature is determined by the condition $T < H^2/8\pi nk$; on the other hand, in order to prevent noticeable diffusion of plasma in the field, the skin layer must not exceed the spark radius (r). This leads to the relation $T > 6.3 \times 10^8 \tau^{2/3} r^{-4/3}$ (where τ is the time constant of the spark), since the skin layer is $d = c\sqrt{\tau/2\pi\lambda}$ and the electric conductivity of the plasma is $\lambda = 10^7 T^{3/2}/z$. Without the first condition the plasma spreads and forces out the magnetic field, and without the second it diffuses in the field. In other words, in order to exert a noticeable effect on the spark geometry, the magnetic field must be so strong that when the pressure plasma drops to the level of the magnetic pressure the plasma temperature remains high enough to prevent noticeable diffusion of the plasma in the field. This leads to the conclusion that there exists a threshold value of the magnetic field, starting with which the field influences actively the spreading of the spark. Under reasonable assumptions concerning the parameters of the spark obtained by us, an estimate leads to a threshold magnetic field on the order of 300 kOe.

Bearing this estimate in mind, we investigated laser breakdown in fields stronger than before (400 kOe). A special installation (which will be described in Trudy FIAN) was developed to produce such fields. The structural features of the installation were determined by the requirements of mechanical strength,

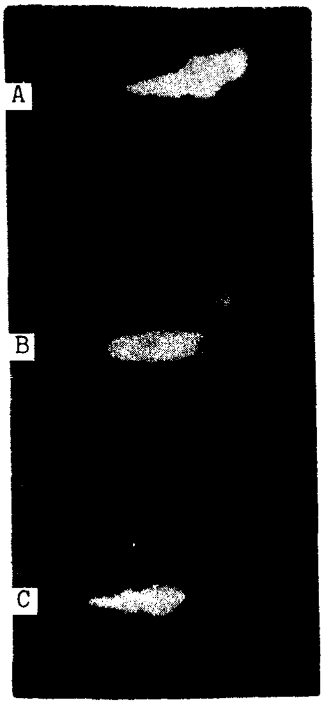

Fig. 1

Fig. 2

Fig. 1. Direction of laser beam from right to left, along the magnetic field.

Fig. 2. Direction of laser beam vertically upwards. Direction of the magnetic field indicated by the arrow.

the possibility of reliable synchronization of the magnetic-field pulse with the laser generation, and operating convenience. The field was produced by a single-turn solenoid [2] fed through a matching pulse transformer. The use of a transformer made it possible to obtain a much longer magnetic-field pulse duration than is obtained by direct discharge of a capacitor into the solenoid, thereby greatly facilitating the synchronization of the field with the laser generation. The transformer made it possible to reduce greatly the current in the supply feeder and to place the 90-kJ capacitor bank outside the laboratory. The installation produced fields with $H = 500$ kOe at a pulse duration of about 100 μsec and a solenoid operating-volume diameter 0.8 cm.

Optical breakdown was produced with a neodymium laser ($\lambda = 1.06\ \mu$) operating either in the mode-locking or in the Q-switching regime. The spark was produced in air at atmospheric pressure and at a laser energy 2 - 3 J.

Comparison of the photographs of the laser spark produced in the volume of the solenoid with the magnetic field turned on and off has shown that the magnetic fields employed by us exert a noticeable influence on the breakdown geometry. As seen from Fig. 1 (a, c), the spark produced by a series of ultrashort pulses in the absence of a magnetic field consists of individual plasmoids, each of which is the result of spherical expansion of the plasma in the interval between the light pulses [3, 4]. In the presence of a magnetic field there are no plasmoids and the spark has the shape of a cylinder with smooth surface (Fig. 1b). The dimension of a spark produced either by a series of picosecond pulses or by a giant pulse increases in the longitudinal direction on the average by a factor 1.5.

As seen from Fig. 2, the direction of the spark development in the case when the magnetic field makes an angle of 40° to the laser beam, is shifted towards the magnetic field. Such a shift is the result of superposition of plasmoids produced by a series of ultrashort pulses. The breakdown centers are located in this case along the laser beam, and each individual plasmoid develops in the direction of the magnetic field.

These results offer evidence that the plasma expansion in the magnetic field is not spherical, but proceeds mainly in the field direction. This is expected to slow down the cooling of the plasma [6].

The noticeable influence exerted by the magnetic field in our experiments on the spark geometry allows us to make an independent estimate of the lower limit of the plasma temperature. The characteristic parameters of the spark are in our experiment $r = 0.1$ cm and $\tau = 3 \times 10^{-7}$ sec, from which it follows that the plasma temperature exceeds 6×10^5 °K.

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INJECTION OF LASER PLASMA INTO A STELLARATOR

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The suggestion of using the plasma produced by interaction of laser radiation with a solid target to fill magnetic traps was advanced long ago [1]. The appreciable rise in laser power had made this idea particularly promising, since it makes it possible to obtain a dense plasma with high ion temperature (total number of particles $\sim 10^{17}$, $T_i \sim 5 \times 10^2$ eV). The use of a laser plasma to fill toroidal magnetic traps, particularly stellarators [4], is of great interest, since it makes it possible to obtain a dense plasma with hot ions. The low electron temperature (on the order of 1 eV) is not a major shortcoming, since the heating of electrons only is a relatively simple problem.

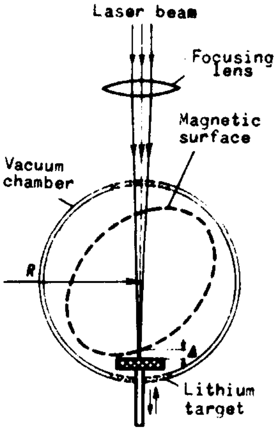

Fig. 1. Diagram of experiment.

We present here the results of a study of the main laws governing the parameters of a captured laser plasma injected into the closed magnetic trap TOR-1 [2], and demonstrate the high efficiency of the capture.

The TOR-1 setup is a stellarator with a two-mode helical field. The major radius of the toroidal vacuum chamber is 60 cm, and its cross-section radius is 5 cm. The experiments were performed at a turn conversion angle 0.72π, and the magnetic field intensity ranged from 3 to 10 kG.

The experimental setup is shown in Fig. 1. A neodymium-laser beam (pulse duration 3×10^{-8} sec, energy 0.5 - 5 J) was focused with the aid of a lens