Figure 1 shows the current-voltage characteristics of the discharge at instants when the current has a maximum. Figure 2 shows microphotographs of the discharge cross section for two different discharge conditions, and Fig. 3 shows a streak photograph of the discharge during the stage of developed instability. As seen from Fig. 1, a distinctive plateau is produced on the current-voltage characteristic at $E \simeq 150$ V/cm. On the other hand, the streak photographs show that at average discharge-current densities corresponding to the start of the plateau on the current-voltage characteristic the discharge ceases to be homogeneous and acquires current filaments having equal increased temperatures, and consequently increased current densities. The number of such filaments increases with increasing average discharge-current density.

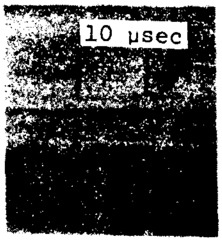

Fig. 3. Streak photograph of discharge during the stage of developed instability.

The distinctive form of the current-voltage characteristic and the inhomogeneity of the discharge at electric fields corresponding to the presence of a plateau on the characteristic indicate that superheat instability develops under the conditions in question, so that at a definite value of the electric field and in a certain current range, the only stable discharge regime is an isothermal fully-ionized plasma is a "two-phase" regime, i.e., one having plasma regions with two different temperatures determined by the radiation and thermal conductivity of the plasma [4]. Such a quasistationary discharge regime is established under the experimental conditions within a time τ much shorter than the characteristic times of discharge evolution (the Coulomb thermal conductivity yields $\tau \sim 10^{-5}$ sec).

The authors are grateful to E.P. Velikhov and A.A. Vedenov for a useful discussion of the results, and A.V. Glukhov for help with the experiment.

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NEW FEATURES OF HeII FILM FLOW TRANSFER

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ZhETF Pis. Red. 15, No. 10, 616 - 618 (20 May 1972)

In the study of He II film flow transfer, great importance is attached to the material of the surface over which the film moves. The investigations of the flow rates, first performed on glass surfaces, were therefore subsequently expanded to include many materials, both metals and plastics. This has made it possible to establish [1] that the transfer flow rates over different surfaces is practically the same as on glass, provided the surface employed is sufficiently smooth.

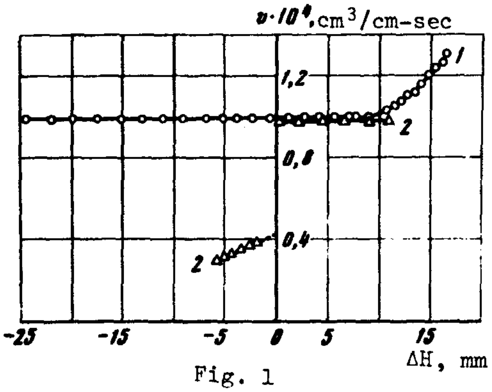

Fig. 1

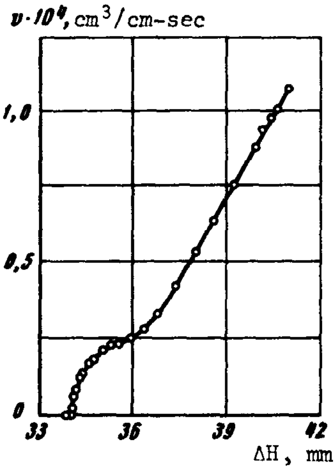

Fig. 2

Fig. 1. Outflow rate (v) of an HeII film vs. the level difference (ΔH) for a Plexiglas ampoule at T = 1.5°K.

Fig. 2. Dependence of the rate (v) of filling of a Plexiglas ampoule through an HeII film on the level difference (ΔH) at T = 1.5°K.

However, in experiments aimed at determining the critical velocity of the film, performed with a conical Plexiglas ampoule, we observed rather unusual phenomena. Since their presence could be connected with the shape of the ampoule, the experiments were subsequently performed with cylindrical Plexiglas ampoules with inside diameter 4 mm and length 50 mm. Such an ampoule was placed in a glass vessel (25 mm diameter) partly filled with liquid helium, and its position relative to the liquid level could be altered with the customarily employed devices [2]. The setup was contained in a dewar with liquid helium, the temperature of which was maintained constant with great accuracy.

The time variation of the liquid-helium level in the ampoule was measured with a cathetometer. Observations were made with the measured level both higher (outflow) and lower (inflow) than the level of the helium in the setup. From the known ampoule dimensions we then determined the transfer rate (in cm²/sec, referred to a unit perimeter of the ampoule cross section) and its dependence on the level difference (ΔH) and on the distance from the highest liquid level to the edge of the ampoule (H).

The results obtained in the case of outflow are shown in Fig. 1 (curve 1). Just as for ordinary materials, the flow transfer rate is at first large so long as the liquid level is close to the edge, then decreases smoothly, after which it changes little with changing ΔH. Unlike the usually observed picture, however, the transfer process does not terminate at ΔH = 0, but continues until the ampoule is completely emptied. For certain ampoules prepared from the same Plexiglas sheet but cut in different directions, a sharp decrease of the rate is observed at ΔH = 0, but even here the outflow continued at negative values of ΔH (Fig. 1, curve 2). Cases were noted when this effect was observed with a new ampoule not immediately, but only during the second or third experiment[1]. One should hardly assume that there is an anisotropy of the properties of the initial material. It is most likely that the cause of this difference lies in processes that are difficult to account for and take place during the preparation of the ampoules. Slight differences in shape may also be responsible (some ampoules, particularly those for which the outflow is characterized by curve 1 of Fig. 1, had a slight flange at the top for fastening).

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[1] This may explain why the indicated phenomena were not observed in an earlier study of the temperature dependence of the flow rate over Plexiglas [3].

When the ampoule was lowered and the inside level was lower than the outside one, the transfer reversed sign. In the case of ordinary surfaces, however, the inflow occurs at practically all values of ΔH and H, whereas in the case of Plexiglas ampoules, for which the outflow is described by curve 1 of Fig. 1, no transfer at all occurred at large values of H, and the level could stay unchanged for a long time. Gradual lowering of the ampoule led to the onset of inflow, starting with H at several millimeters. Even then, however, the inflow did not continue until the levels became equalized, as is usually observed, but stopped suddenly at values of ΔH far from zero (Fig. 2).

Special experiments performed simultaneously with two ampoules, one glass and the other Plexiglas, have shown that the indicated phenomena are observed for a Plexiglas ampoule but not for a glass one. This eliminates the possibility that the experiments were performed under non-equilibrium conditions. Both ampoules behave identically in HeI near the λ point, and no change of the liquid level with time was observed in either.

Thus, both outflow and inflow over Plexiglas ampoules exhibit singularities not observed with ordinary materials.

One cannot exclude the possibility that the indicated phenomena are connected with the electric state of the Plexiglas, which, as is well known, electrifies easily. When the ampoule is prepared and cooled, its surface can become electrified, and then the motion of the HeII film is subjected to the action of appreciable forces, which can change significantly the character of the transfer phenomenon. A better argumented evaluation of the nature of the described phenomenon will probably become possible when new experiments are performed with ferroelectric ampoules, and with an electric field of controlled direction and magnitude.

It should be noted that the possibility of regulating the film transfer process can be of considerable interest when it comes to producing infralow temperatures.

In conclusion, we take the opportunity to thank B.G. Lazarev and A.I. Shal'nikov for fruitful discussions.

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CONCERNING THE MECHANISM OF CHARGED-PARTICLE ACCELERATION IN A DYNAMIC Z-PINCH

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Submitted 17 April 1972
ZhETF Pis. Red. 15, No. 10, 619 - 622 (20 May 1972)

Acceleration of the charged particles responsible for the generation of x- and neutron radiation is frequently observed in a dynamic Z-pinch. To explain this effect, various mechanisms were proposed, but none agreed sufficiently well with the experimental data [1].

We begin our discussion of the mechanism proposed by us by listing the main experimental facts[1)] [1 - 3]: (1) the acceleration of the ions and electrons occurs simultaneously and to approximately the same energies; (2) the acceleration region is localized along the discharge axis and its transverse dimension

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[1)] This question will be discussed in detail in a separate article.