change of the character of the state density in the conduction band in the ultraquantum region. It should also be noted that a large value of $\chi_2$, close to $\chi_1$, in semiconducting Bi-Sb alloys can make it very difficult to observe the anomalies of the magnetic characteristics of the medium [4] in the case of electronic transitions in strong magnetic fields [8].

We take the opportunity to thank V. S. Zemskoi, V. V. Rozhdestevenskaya, and A. D. Belaya of the Baikov Metallurgy Institute for supplying the samples, G. N. Ronami for analyzing them with the "Cameca" apparatus, and A. S. Borovik-Romanov for a useful discussion of the results.

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## METASTABILITY OF LIQUID PHASE UNDER CONDITIONS OF DEVELOPED EVAPORATION OF CONDENSED MEDIA

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Submitted 10 December 1973
ZhETF Pis. Red. 19, No. 2, 111 - 114 (20 January 1974)

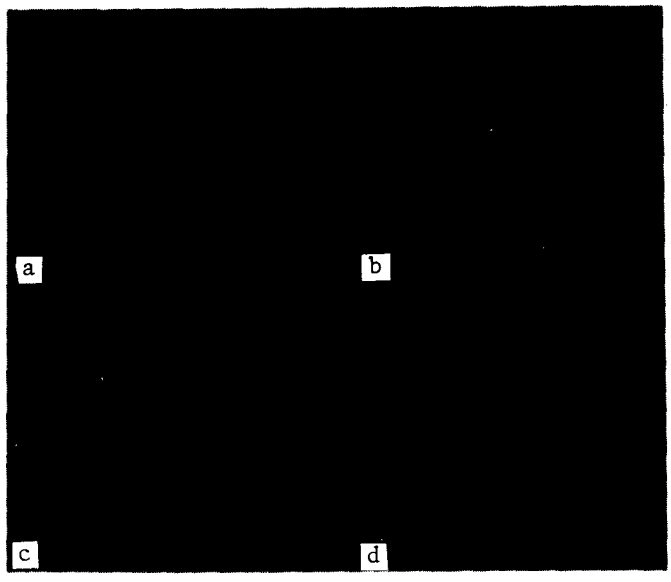
We report direct experimental observation of metastability of a superheated liquid phase under conditions of developed evaporation of condensed media by electromagnetic radiation.

When sufficiently intense radiation acts on the surface of an absorbing condensed medium, the temperature of the material in the surface layer can exceed the boiling temperature $T_B$ (developed evaporation). The superheat phenomenon was discussed repeatedly from the point of view of the ratio of the surface to volume evaporation (see, e.g., [1, 2]), but the influence of the metastability of the superheated layer on the dynamics of the evaporation process remains unclear. Some possible manifestations of the metastability of the liquid phase were noted recently in [3 - 5]. We report here the first experimental observation of metastability under conditions of developed evaporation.

A metastable liquid phase has a finite lifetime that depends very strongly on the degree of superheat. This enables us to speak of a limiting superheat temperature $T_L$ that depends on the external pressure p [6]. Under conditions of developed evaporation, p is determined by the surface temperature $T_0$ and amounts to approximately half the saturated-vapor pressure $p_S(T_0)$. When the radiation intensity I is abruptly decrease, the surface temperature drops, and this leads to a decrease of $p(T_0)$. If $T_L(p)$ is in this case lower than the actual temperature inside the still uncooled liquid layer, then a rapid (explosive) transformation of the metastable liquid into a heterophase system takes place. Estimates of the principal characteristics of this effect are given in [4] for strongly absorbing media (metals).

We consider here the case when the reciprocal absorption coefficient $\alpha^{-1}$ is not small in comparison with the characteristic length of the temperature influence in the stationary regime, $\chi/v$, which is determined by the temperature-conductivity $\chi$ and by the velocity v of the evaporation boundary. Under these conditions ($\alpha\chi/v \ll 1$), the maximum temperature inside the superheated layer can reach values $T_0 + \varepsilon/c$, where $\varepsilon$ and c denote respectively the heat of evaporation and the specific heat per unit volume [7]. This quantity, however, usually exceeds the critical temperature $T_c$, so that a stationary regime of developed evaporation is actually not realized in this form. If the radiation pulse is long enough, the metastable state should decay as soon as the temperature inside the superheated layer reaches $T_L$. If the initial liquid temperature is T(0), then the time needed to attain $T_L$ is $t_0 \approx c\Delta T/\alpha I$, where $\Delta T = T_L - T(0)$.

However, even before the temperature inside the layer rises to $T_L$, the temperature on the




Lower curve - microphone signal, upper curve - radiation pulse. (Sweeps: a - c) 0.5 msec/div, d) 2.5 msec/div.

surface can already greatly exceed $T_B$, this being a characteristic attribute of developed evaporation. If I is abruptly decreased in this case, then the corresponding lowering of $T_L$ can cause decay of the metastable state at $t < t_0$, and the instant of the explosion will coincide with the rear edge of the radiation pulse. This effect was observed in an experiment, which was performed in the following manner.

Radiation from a $CO_2$ laser ($\lambda = 10.6\mu$) operating continuously with a rotary-disk shutter, was focused on the free surface of a liquid (acetone, ethanol). The focal-spot area was 0.0025 $cm^2$, corresponding to an approximate intensity I of 6000 $W/cm^2$. The explosive decay of the metastable state was accompanied by a characteristic sound, which was registered with a microphone located over the surface of the liquid, approximately 4 cm from the focal spot[1]. The irradiation-pulse duration was variable and amounted to several milliseconds at a repetition frequency on the order of several cycles per second.

For acetone under the considered conditions, the minimum pulse duration at which an explosion of the metastable state was still observed was 2.5 msec. When the exposure to the radiation was increased to 3.5 msec, the instant of explosion shifted together with the trailing edge of the pulse, and the amplitude of the sound signal increased noticeably (Figs. a - c). An estimate of the maximum delay time, using the formula $t_0 = c \cdot \Delta T/\alpha I$, yields in this case an underestimated value ($< 10^{-3}$ sec) because, in particular, the characteristic length of the nonstationary temperature influence, $\sqrt{\chi t} \approx 2 \times 10^{-3}$ cm, turns out to be of the same order as $\alpha^{-1}$, and the thermal conductivity cannot be neglected under these conditions.

Further increase of t leads to the appearance of one more explosion, i.e., the regime turns out to be periodic. A pulsating regime is typical of developed evaporation, owing to the screening of the incident radiation by the outflowing products and owing to the cooling of the surface. In our case, a characteristic feature of the regime is the regular periodicity, as is clearly seen in Fig. d (ethanol).

In the case of ethanol, however, we oberved no noticeable dependence of the instant of explosion on the pulse duration. This difference from acetone can be attributed qualitatively to the fact that for ethanol the value $\varepsilon = 734$ $J/cm^3$ is much larger than for acetone, $\varepsilon = 393$ $J/cm^3$. For this reason the surface temperature of ethanol increases relatively more slowly, and by the time that the temperature $T_L$ is reached the surface temperature still differs little from $T_B$ (we note also that the difference $T_c - T_B$ of acetone is larger than that for ethanole, 179 as against 165°). In other words, in the case of ethanol the decrease of intensity is not accompanied by a noticeable decrease of $T_L$ and does not lead to an earlier decay of the metastable state.

We note in conclusion that the behavior of the surface of the liquid in the region of the focal spot of the radiation was monitored also with a thin beam of visible light (He-Ne laser, $\lambda = 0.63$ $\mu$), experiencing total internal reflection from the surface of the liquid. At the instant of decay of the metastable state, a strong scattering took place, due to disruption of

the interface and the onset of the heterophase system The results of a more detailed investigation of the metastability effect under conditions of developed evaporation (the dependence on the intensity, on the pulse waveform, etc.) will be reported separately.

The authors thank A. M. Prokhorov for interest in the work and valuable remarks.

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[1] We emphasize that under the considered conditions the acoustic signal is due precisely to the decay of the metastable state, and not to the change in the recoil pressure of the escaping gases at the start and end of the radiation pulse [8].

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## FOCUSING OF ELECTRONS IN A METAL BY A TRANSVERSE MAGNETIC FIELD

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Submitted 10 December 1973
ZhETF Pis. Red. 19, No. 2, 114 - 116 (20 January 1974)

A microcontact technique was used to observe the focusing of electrons in bismuth by a transverse homogeneous magnetic field. Focusing in multiple fields was observed.

Sharvin has proposed [1] and realized with his co-workers [2, 3] an experiment in which he produced and observed electron beams produced in metals have large mean free paths; the electrons emerged from a definite point of the sample and were focused by a longitudinal magnetic field onto another point of the sample.

It is of interest to focus the electrons in a transverse homogeneous magnetic field. The experimental setup used for this purpose is shown in Fig. 1. Two thin needles B and C of copper wire of 0.1 mm diameter were welded to a single-crystal bismuth plate M of 2 mm thickness, in which the $C_3$ axis was perpendicular to the surface. The distance between the needle points was $L \approx 0.15$ mm, and the contact diameter was on the order of a micron. Current of 500 μA was made to flow through the circuit of point B. The voltage difference U between the point C and the peripheral point of the sample was registered with a galvanometric amplifier V and an automatic recorder. The sample was placed in a magnetic field H that could be varied in magnitude and

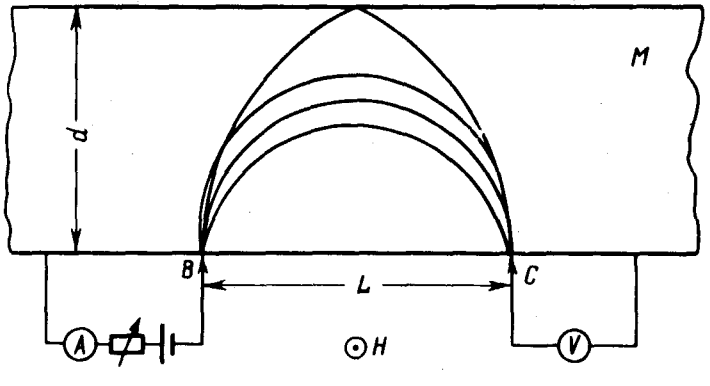


Fig. 1. Diagram of experiment