In our estimates we disregard the variation of the real part of the dielectric constant. This variation may be due to heating of the medium in the focal region or to the Stark effect in the light field. Since according to our estimates the local heating prior to the onset of damage in the ruby, at constant volume, does not go beyond 1000°, the signal produced by the change of ϵ is not more than 10^3 V, i.e., smaller than the observed signal by two orders of magnitude.

The Stark effect can be disregarded in our case, since it has no inertia. The kinetics of the conductivity signal observed by us differs from lasing action. Figure 2 shows the conductivity signal taken with a sweep of 100 nsec per division. An increase in the conductivity is observed during the generation time (~50 nsec). The prolonged attenuation is apparently due to the capture of the electrons by the shallow traps near the bottom of the conduction band of the corundum.

Absorption from the excited ^2E level should be manifest in the dependence of the absorption coefficient on the intensity of the incident laser light. Figure 3 shows this dependence (curve 1). Curve 2 in the same figure shows the variation of the absorption coefficient, calculated for a two-level system. This curve lies lower than the experimental one. The difference increases with increasing intensity of the incident light.

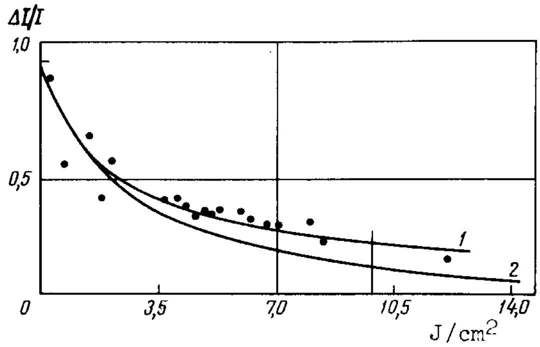

Fig. 3. Ruby absorption coefficient vs. incident light intensity. 1 -- Experimental curve, 2 -- theoretical.

It follows therefore that there exists additional absorption, which increases with the intensity of the light. We assume that it is due to two-photon processes from the excited level.

The vertical line in Fig. 3 shows the minimum energy at which the conductivity is observed.

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MAGNETIC MOMENT OF A SUPERCONDUCTING ELLIPSOID IN A MIXED STATE

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It is known that in superconductors of type I, whose interface between the normal and superconducting phases has positive surface energy α_{ns}, the transition from the superconducting into the normal state takes place in all cases (with the exception of an infinitely long cylinder with axis parallel to the external magnetic field $\vec{H}_0$) not jumpwise but continuously in a field interval from $(1 - n)H_c$ to H_c, where n is the so-called demagnetizing factor of the body. When $(1 - n)H_c < H_0 < H_c$ the superconductor is in the intermediate state. It breaks up in this case into alternating regions of normal and superconducting phases which are in equilibrium when $H = H_c$ ($\vec{H}$ is the field inside the superconductor and H_c is the critical field).

In superconductors of type II [1], in which the surface energy α_{ns} is negative, the transition of a long cylinder in a parallel field ($n = 0$) is also realized in a field interval from H_{c1} to H_{c2}, where H_{c1} and H_{c2} are called Abrikosov's lower and upper critical fields. When $_{c1} < H_0 < H_{c2}$ the superconductor is in a mixed state [1], in which it is pierced by quantized filaments of magnetic flux, which form a superstructure (two-dimensional lattice) under equilibrium conditions. Abrikosov has shown that the intermediate state in superconductors of type II is not realized if the phase transition is a second-order one. In this paper we investigate the manner in which the superconductivity is destroyed by a magnetic field in bulky specimens of superconductors of type II with a nonzero demagnetizing factor.

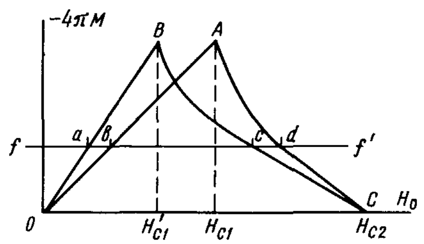
In the case of an ellipsoidal body, the distribution of the magnetization inside the sample is macroscopically homogeneous, with $\vec{M} \parallel \vec{H}_0$, $\vec{B} \parallel \vec{H}_0$, and $\vec{H} \parallel \vec{H}_0$, where $\vec{B}$ is the induction and $\vec{M}$ the magnetic moment per unit volume. According to [2,3] the quantities $\vec{B}$, $\vec{H}$, $\vec{H}_0$, and $\vec{M}$ are connected by

$$B = H + 4\pi M, \quad H = H_0 - n(B - H), \tag{1}$$

hence

$$H_0 = H + 4\pi n M(H). \tag{2}$$

Together with the equation that determines the dependence of M on H, i.e., the magnetization curve (for $n = 0$), these equations make it possible to plot H, B. and M against H_0, i.e., to determine the magnetization curve of a real body.



The form of M(H) for superconductors of type II is shown schematically in the figure (curve OAC). When $H < H_{c1}$ we have $M(H) = -H/4\pi$, which yields after substitution in (2) $H_0 = (1 - n)H$. Consequently, if the external field H_0 satisfies the condition $H_0 < H'_{c1} = (1 - n)H_{c1}$, the dependence of M on H_0 is given by

$$M = -\frac{H_0}{4\pi(1 - n)} \tag{3}$$

(segment OB in the figure).

At the point $H_0 = H'_{c1}$ the $M(H_0)$ curve has a kink, after which it becomes similar to the curve AB. It is clear that the penetration of the field terminates at the point $H_0 = H_{c2}$. At this point $H_0 = H = H_{c2}$ and $M(H_{c2}) = 0$. In the field interval $H'_{c1} < H_0 < H_{c2}$ we get a mixed state. The equation of the $M(H_0)$ curve is determined in this interval on the basis of relation (2).

It is easily shown that the segments ab and cd intercepted by the curves OAC and OBC on the line ff' which is parallel to the abscissa axis are equal:

$$ab = cd. \tag{4}$$

This yields a simple geometric method of plotting the curve BC from the known curve AC. It is easily seen that by virtue of (4) the areas under the curves OAC and OBC are equal (and, in accordance with the theory [1], they are equal to $H_c^2/8\pi$, where H_c is the thermodynamic critical field):

$$\int_0^{H_{c2}} M(H)\,dH = \int_0^{H_{c2}} M(H_0)\,dH_0 = -\frac{H_c^2}{8\pi}. \tag{5}$$

The last equation can be proved purely analytically, by starting directly from (2). Indeed, differentiating (2), we obtain

$$dH_0 = (1 + 4\pi\mu(H))\,dH, \quad \mu(H) = dM/dH. \tag{6}$$

Using further formula (3), we get:

$$\begin{aligned}\int_0^{H_{c2}} M(H_0)\,dH_0 &= \int_0^{H'_{c1}} \left(-\frac{H_0}{4\pi(1-n)}\right)dH_0 + \int_{H_{c1}}^{H_{c2}} M(H)(1 + 4\pi n\mu(H))\,dH = -\frac{(1-n)H_{c1}^2}{8\pi}\\ &+ \int_{H_{c1}}^{H_{c2}} M(H)\,dH + 2\pi n[M^2(H_{c2}) - M^2(H_{c1})] = -\frac{H_{c1}^2}{8\pi} + \int_{H_{c1}}^{H_{c2}} M(H)\,dH = \int_0^{H_{c2}} M(H)\,dH.\end{aligned} \tag{7}$$

The question of the influence of the sample geometry on the transition in a magnetic field has thus a unique solution for superconductors of type II, just as for superconductors of type I. The difference lies in the fact that in the case of type I this transition is via an intermediate state, whereas in the case of type II it does not differ in principle from the transition of a long cylinder in a parallel field, i.e., it is realized with the aid of the mixed state introduced by Abrikosov [1].

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