3. Collisions with impurities do not change (6) or (7) if $\lambda_x \ll \ell_x$, where $\ell_x = \tau v_x$ is the mean free path in the x direction, i.e., if

$$(\hbar\Omega/\epsilon_F)^{2/3}\epsilon_F \gg \hbar/\tau. \tag{9}$$

The meaning of condition (9) is that the distance between the MSL should be large compared with the damping h/τ. The condition (9), which is the most stringent of all the foregoing, is nevertheless satisfied for fields 0.1 -10 Oe (it is meaningful to measure $M^{(s)}$ in this interval at a range ℓ_0 = 1 - 0.1 mm).

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FILM SUPERCONDUCTIVITY STIMULATED BY A HIGH-FREQUENCY FIELD

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A number of problems pertaining to nonlinear electrodynamics of small-size superconductors have been considered recently [1, 2]. In each case the result was that an alternating electromagnetic field, by decreasing the ordering parameter Δ, exerted a destructive action on the superconducting properties, just as in the case of constant magnetic field or current.

Yet, as will be shown here, such a situation obtains only for field frquencies below a certain critical value ω_c, and when $\omega > \omega_c$ the high-frequency field should increase Δ.

To illustrate the physical nature of this phenomenon, let us turn to the principal equation of the BCS theory [3]

$$\Delta = g\int_{\Delta}^{\hbar\omega_D} d\epsilon \frac{\Delta}{\sqrt{\epsilon^2 - \Delta^2}}[1 - 2n(\epsilon)], \tag{1}$$

which determines the dependence of the energy gap Δ on the distribution function $n(\varepsilon)$. At equilibrium we have $n(\varepsilon) = (e^{\varepsilon/T} + 1)^{-1}$. An alternating field of frequency $\omega < 2\Delta/h$, when absorbed by the excitations, will shift the "center of gravity" of $n(\varepsilon)$ towards larger values of ε, keeping the total number of excitations constant. Such a shift of n, as seen from (1), will lead to an increase of Δ, owing to the decrease of the level density with increasing distance from the threshold. The actual change of $n(\varepsilon)$ will be proportional to the field intensity E^2 (at not too large E) and to the energy relaxation time τ_0 of the excitations.

A very favorable circumstance is in this case the large value of τ_0 (as is well known, $\tau_0 \sim h\theta_D^2/T^3$ or hE_F/T^2 for the electron-phonon and electron-electron mechanisms).

The picture is complicated, generally speaking, by the fact that Δ is a quantity that varies in space and in time in the presence of a field. There is no coordinate dependence in the case of sufficiently thin samples. It turns out that the time oscillations of Δ can also be disregarded. The point is that interest attaches to frequencies much higher than τ^{-1}, the reciprocal relaxation time of the ordering parameter. Near T_c we have [4, 5, 6]

$$\tau \sim \tau_0 \sqrt{\frac{T_c - T}{T_c}}. \tag{2}$$

But when $\omega\tau >> 1$ the amplitude of the oscillations is much smaller than the time average of Δ [1]. Under these conditions the problem reduces to a determination of $n(\varepsilon)$ in the presence of an alternating field. We confine ourselves here to the case of not too high alternating field intensities, when it sufficies to take into account in (1) terms of second order in the potential $A(t) = A_\omega \cos\omega t$. We can then use formulas (7), (8), and (16) of [6], making in the appropriate places the substitution $\omega_0 \to \omega_0 + 2i\gamma$ and putting $\omega_0 = 0$[1] ($\gamma = \hbar\tau_0^{-1}$ is the damping of the excitations, which coincides near T_c with the damping for the normal metal [7]). As a result we obtain the following equation for the time-averaged:

$$\left\{\frac{T_c - T}{T_c} - \frac{7\zeta(3)}{8(\pi T_c)^2}\Delta^2 - \frac{\pi}{6T_c}\frac{\ell v e^2}{\hbar c^2}\left[A_0^2 + \frac{A_\omega^2}{2}\left(1 - \frac{\hbar\omega}{2\pi\gamma} f\left(\frac{\hbar\omega}{\Delta}\right)\right)\right]\right\}\Delta = 0, \tag{3}$$

where ℓ is the mean free path, determined by scattering from defects, and A_0 is the potential representing the constant magnetic field or current. The function $f(\hbar\omega/\Delta)$ has a rather complicated form, and will be written out for the limiting cases:

$$f(u) \approx u \ln\frac{8}{u}, \quad u << 1$$
$$f(u) \approx \frac{\pi}{u}, \quad u >> 1. \tag{4}$$

As seen from (3) and (4), when $\omega > \omega_c$, where

$$\omega_c^2 \ln\frac{8\Delta}{\hbar\omega_c} = \frac{2\pi}{\hbar^2}\gamma\Delta. \tag{5}$$

the alternating field leads to an increase of Δ.

The logarithmic factor in (5) is connected with the root singularity of the spectral density in the model under consideration.

A much higher sensitivity to the form of the spectrum arises in the determination of the region of applicability of (3) with respect to the field intensity. Estimating the terms $\sim A_\omega^4$, we can conclude qualitatively that the region of applicability of (3) (and with it also the possible magnitude of the effect) increase following a certain smearing of the root

[1] Such a procedure can be justified with the aid of the kinetic equations, in which account is taken of the inelastic collisions of the electrons. Their derivation and investigation will be presented elsewhere.

singularity. Without entering into a more detailed discussion of this question, we note only that there exists a definite limitation on the possible increase of Δ: since the role of the high-frequency field reduces to a weakening of the temperature factor, it follows that $\Delta < \Delta(T = 0)$.

Let us list some of the singularities of the superconducting state, stimulated by an alternating field: 1) It can be readily seen from (3) and (4) that a plot of $T(\Delta)$ with $\omega > \omega_c$ and fixed field intensity has a maximum at $T > T_c$.[2)] The question whether the state at $T > T_c$ will be stable or metastable remains open for the time being. 2) An analogous picture should be observed also when a constant magnetic field H is applied. As is well known, the transition of a thin film from the superconducting to the normal state under the influence of a magnetic field is a second-order transition. In the presence of an alternating field, the $H(\Delta)$ curve has a maximum at $H > H_c$ and the destruction of superconductivity occurs at a finite value of Δ. 3) The increase of the critical current in the presence of an alternating field also follows directly from (3) when $\omega > \omega_c$. In all probability, this is precisely the phenomenon observed by Dayem and Wiegand [8]. The existence of a critical point for the effect observed by them, and the order of magnitude of the latter, are in qualitative agreement with (5).

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INVESTIGATION OF THE PROCESS OF RESONANT CHARGE EXCHANGE IN THE He^4 - He SYSTEM

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1. The effective cross section for resonant charge exchange, in the approximation of two states, is given by the formula

$$\delta = 2\pi\int_0^\infty b\,\mathrm{Sin}^2(\eta_g - \eta_u)\,db, \tag{1}$$

where b is the impact parameter, and $\eta_g - \eta_u$ is the phase difference between the even and odd states. Smith [1] has shown that if the phase difference $\eta_g - \eta_u$ is stationary in a certain interval b, then the function (v) (v - velocity of relative motion) has an oscillating character. One of the reasons why the phases are stationary is the presence of a maximum

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[1)] It must be borne in mind that A_ω is the field inside the film. The coefficient connecting A_ω with the external field is determined by the geometry of the experiment, and in general is dependent on Δ.