gular correlations between the γ transitions with energy 298 kev and with energy above 750 kev. Ofer[5] measured the angular correlation separately for a number of γ cascades and particularly for the 298 — 880 kev and 298 — 966 kev cascades. The obtained results, especially for the 298 — 966 kev cascade, show that the 1264-kev level has the characteristic 2^- and dipole transition with energy 298 kev; the possible admixture of quadrupole radiation is less than 1/1000. The data for the 298 — 880 kev cascade obtained in the same paper lead to the transition sequence 2(D), 2(D+Q)2 for $\delta^2 = 3600$, i.e., the intensity of the quadrupole radiation is 3600 times that of the dipole. There are no indications in the paper, however, of any correction for the contribution of the angular correlation of the 298 — 966 kev cascade in measuring the angular correlation of the 298 — 880 kev cascade.

We have measured the angular correlation of the 298 — 966 kev and 298 — 880 kev γ cascades with the apparatus previously described.[7]† To prevent false coincidences due to Compton scattering from one crystal to another, the crystal used to count the 880 and 966 kev photons was screened with a lead filter 5 mm thick on the front and 4 mm on the side surface. For measurements at 90 and 135°, a lead screen 5 mm thick was interposed between the crystals. After introducing corrections for the variations of the single loadings in the counters and for the finite angular resolution of the detectors, the angular correlation function of the 298 — 966 kev cascade was found to be

$$W(\theta) = 1 + (0.23 \pm 0.03) P_2(\cos\theta),$$

corresponding to the sequence of transitions 2(D+Q)2(Q)0 if the mixture ratio $\delta^2 = I(Q)/I(D)$ in the 298-kev transition is less than 1/1000. The obtained result entirely agrees with the measurement of the angular correlation of this cascade by Ofer.[5] By a suitable adjustment of the window of the pulse-height analyzer, the 966-kev γ line was practically completely separated from the 880-kev γ line.

In measuring the angular correlation of the 298 — 966 kev cascade corrections were made for the contribution of the angular correlation of the 298 — 966 kev cascade, for the variation of the single loadings in the counters, and for the finite angular resolution of the detectors. As a result, the following angular correlation function was obtained for the 298 — 880 kev cascade:

$$W(\theta) = 1 - (0.116 \pm 0.037) P_2(\cos\theta).$$

If account is taken of the results obtained for the 298 — 966 kev cascade, this correlation function agrees best with the transition sequence 2(D)2(D+Q)2, where the mixture ratio δ^2 in the 880-kev γ transition should be ≈ 56 ($\delta < 0$), i.e., the intensity of the dipole radiation (M1) in the the 880-kev γ transition should constitute (1.8 ± 1.5)% and the intensity of the quadrupole radiation (E2) should be (98.2 ± 1.5)%. This result differs from the result of Ofer,[5] who found the 880-kev transition to be practically pure Q.

From our work it follows that the spin of the 1264-kev energy level is 2.

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†We take this opportunity to correct an error made in reference 7. On page 1364, line 9 from the bottom should read "spin 9/2" (instead of 3/2), line 7 from the bottom should read "spin 3/2" (instead of 9/2).

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CRITICAL CURRENTS IN SUPERCONDUCTING TIN FILMS

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THE most interesting measurements of critical currents in superconducting films are those on films of such geometry that the magnetic field

due to the current can be calculated and compared with theory. Since measurements on such films have either been made with continuous current[1,2] or with long period pulses (0.1 — 0.01 sec)[3] there was the danger that the small values of critical current are a consequence of Joule heating of the film. It therefore seemed of interest to extend the measurements to the region of shorter pulses. In the present work we have measured the critical currents in tin films by a pulse method, with the time of rise varying between $\tau = 0.1$ and $\tau = 0.0001$ sec.

As before,[3] the film was a flat disk with a central current lead and a radial distribution of current flow. The measurements showed that the critical current depends appreciably on the time τ, increasing as it decreases (Fig. 1). For example, for a film of thickness $d = 2.0 \times 10^{-5}$ cm the critical currents for $\tau = 0.01$ and $\tau = 0.0001$ sec differ by a factor of two. We should note that when the temperature is reduced by 0.3 — 0.4° K below the critical temperature, the critical current increased to 10 amp for $\tau = 0.0001$ sec.

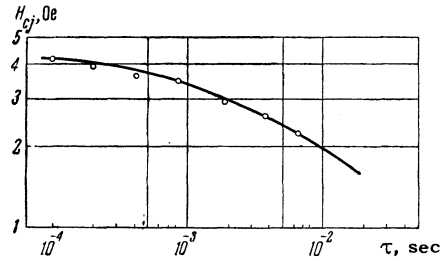

FIG. 1. Dependence of the magnetic field of the critical current, H_{cj}, on the time of rise of the current pulse for a tin film of thickness $d = 2.03 \times 10^{-5}$ cm.

If the critical field due to the current, H_{cj}, is plotted against τ, it is seen that H_{cj} tends to a constant value as τ is reduced. By extrapolating to τ equal to zero, the critical current is almost the same (5 — 10%) as the experimental value for $\tau = 0.0001$ sec. The experimental data discussed below refer to measurements made with the shortest pulses.

Our results show that near the critical temperature the form of the H_{cj} vs. ΔT curve ($\Delta T = T_c - T$) depends appreciably on the temperature of the substrate at the time of deposition of the film. For films obtained by evaporating the metal in vacuum onto a substrate cooled to liquid nitrogen temperature (78° K) and then warmed up to room temperature, the temperature dependence of H_{cj} can be roughly represented by the relation $H_{cj} = a\Delta T$ (see Fig. 2). Films obtained by evaporation at room temperature show a temperature dependence of critical current field near T_c close to that predicted by the Ginzburg-Landau theory[4,5] (see Fig. 3), although such films are

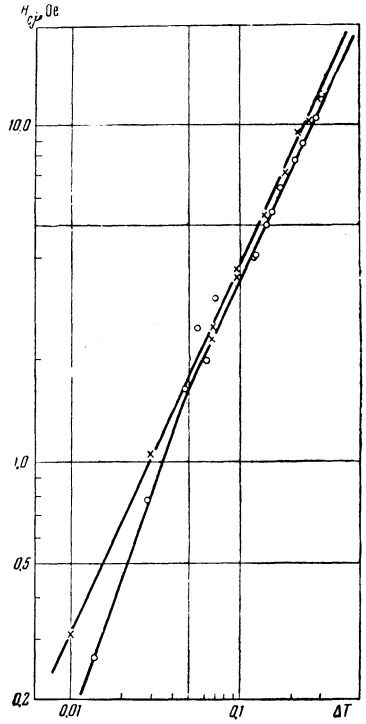

FIG. 2. Dependence of the field of the critical current on temperature (ΔT) for a tin film of thickness $d = 2 \times 10^{-5}$ cm. × — film deposited on a substrate cooled by liquid nitrogen, and the measurements made with current pulses for which the time of rise was $\tau = 4 \times 10^{-4}$ sec; o — film deposited on a substrate at room temperature, $\tau = 2.5 \times 10^{-4}$ sec.

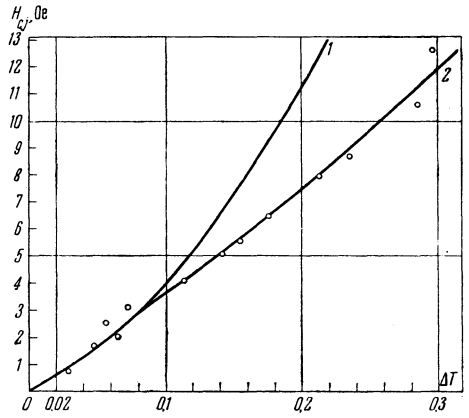

FIG. 3. Temperature dependence of field of the critical current for a tin film of thickness $d = 2 \times 10^{-5}$ cm, $\tau = 0.00025$ sec. Curve 1 is theoretical, calculated from Eq. (1); curve 2 is experimental. The film was deposited on a substrate at room temperature.

less reliable than films condensed at liquid nitrogen temperature. For these films there is a change in slope of the curves in the range $\Delta T = 0.05 - 0.1°$ K. After the break, the form of the temperature dependence of H_{cj} for these films is the same as for films condensed at T = 78° K.

The calculated values of H_{cj} near T_c are, in both cases, close to the theoretical values calculated from the relation

$$H_{cj}/H_{cm} = (\sqrt{2}/3\sqrt{3})\, d/\delta, \qquad (1)$$

where d is the film thickness; δ_0 is taken as 6.5×10^{-6} cm, as follows from Zavaritskiĭ's work.[6]

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THE SUPERCONDUCTIVITY OF ELECTROLYTICALLY DEPOSITED COPPER-BISMUTH ALLOYS

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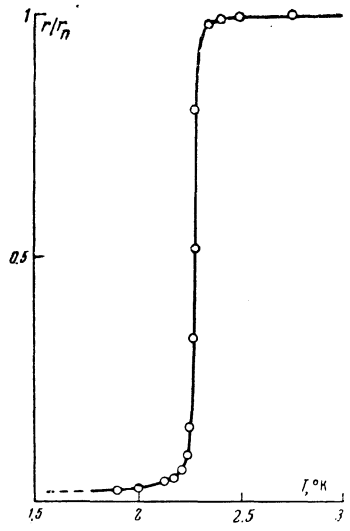
WHILE studying the phase structure of electrolytically deposited copper-bismuth alloys, it was found that, depending upon the value of the overvoltage at the cathode, alloys could be obtained containing both mixtures of copper and bismuth crystals (in agreement with the equilibrium diagram of this system) and non-equilibrium phases.[1] Alloys consisting of non-equilibrium phases occurred at high overvoltages at the cathode in the form of dense silver-colored deposits in the composition range 40 to 90 wt % bismuth.

Data obtained by thermal analysis and x-ray studies allowed the supposition that these alloys contained a non-equilibrium phase, the decomposition of which occurred at a temperature of about 120° C. In alloys containing between 40 and 60 wt % bismuth, on the basis of thermal analysis data, we succeeded in discovering, as well as the non-equilibrium phase mentioned, yet another unstable phase, the decomposition of which started at a temperature of about 60° C. The absence in x-ray photographs of reflections from this phase prevented the establishment of its nature.

The existence of superconductivity has been shown in unstable compounds of bismuth with rhodium and various other metals;[2,3] it was, therefore, of interest to explore the possibility that superconductivity might appear also in the copper-bismuth alloys described above. Electrolytic deposits of copper-bismuth alloys were obtained from a solution of the following composition: 1N $Cu(ClO_4)_2$, 4N $Bi(ClO_4)_3$, 4N $HClO_4$. The deposits were obtained with current densities of from 80 to 250 ma/cm^2. The amount of bismuth in the alloys varied from 25 to 90 wt %. For the measurements specimens in the form of copper plates $30 \times 3 \times 0.05$ mm were used, on both sides of which the copper-bismuth alloy was deposited electrolytically. Measurements on such specimens in liquid helium showed that on lowering the temperature their electrical resistivity fell sharply (see Figure; Cu-Bi alloy with 20% Cu). The resistance drop usually occurred close to 2° K, and changed slightly on changing the amount of copper in the alloy.



If the specimens were annealed at 120° C, the resistance drop was not observed on re-measuring down to 1.5° K. It should be noted, however, that if the anneal was at 80° C, the resistance drop did not disappear. The sharp decrease of specimen resistance was naturally considered as due to the transi-