| Element | Atomic number | First appearance of electron number | Pressure, atm | |
|---|---|---|---|---|
| | | | TF model | Model with corrections |
| K | 19 | 2 | $1.57 \times 10^5$ | - |
| Ca | 20 | 2 | $1.91 \times 10^4$ | - |
| Sn | 50 | 3 | $1.54 \times 10^7$ | $1.03 \times 10^7$ |
| Te | 52 | 3 | $6.32 \times 10^6$ | $2.08 \times 10^6$ |
| Ba | 56 | 3 | $1.57 \times 10^5$ | $3.17 \times 10^3$ |

The table lists for several elements the calculated pressures in the TF model and in the model with the quantum corrections.

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## CONCERNING THE QUANTIZATION OF THE ENERGY LEVELS OF ELECTRONIC EXCITATIONS IN THE INTERMEDIATE STATE OF A SUPERCONDUCTOR

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The transition of a metal into an intermediate state is accompanied by a sharp decrease in the thermal conductivity of the electronic excitation [1], thus evidencing their reflection from the boundary between the normal and superconducting phases. It was shown in [2] that the excitations suffer a strict reversal of the motion upon reflection. As a result, motion of the excited normal phase sets in between its boundaries, leading to quantization of the energy levels with characteristic energy $\epsilon_0 = \hbar v/a$, where v is the velocity of the electrons on the Fermi surface and a is the dimension of the regions of the normal phase of the intermediate state [3].

Quantization of the energy levels should lead to a change in many characteristics of the normal phase, particularly to a decrease in the specific heat C in the temperature region $kT < kT_0 = \epsilon_0$. The present investigation was undertaken to ascertain the extent to which this decrease actually takes place.

The object of the investigation was a cylindrical single crystal 2.6 mm in diameter, made of tin with $10^{-4}$% impurities. The measurements were made in the temperature interval 0.1 - 0.3°K in magnetic fields corresponding to fractions $\eta \approx 0.08$, 0.15, 0.3, and 0.45 of the normal phase in the sample. The widths of the layers of this phase were, in accordance with the calculation [1], $3 \times 10^{-3}$, $4 \times 10^{-3}$, $5 \times 10^{-3}$, and $8 \times 10^{-3}$ cm, corresponding to estimated values ~ 0.3, 0.25, 0.2, and 0.12°K for $T_0$. During the course of the experiment we measured the thermal conductivity K and the temperature conductivity $a^2$, from which the specific heat was calculated [4].

The method of measuring the thermal conductivity does not differ from that employed earlier [4]. The results of the measurements are shown in Fig. 1a. In the investigated temperature region, the thermal conductivity is due to the transfer of heat by the phonons [4]. The sharp decrease, reaching a factor as much as 10, in the value of K in the intermediate state is due to the additional scattering of the phonons by the electrons of the normal regions [1]. As can be seen from Fig. 1a, in the case $\eta \sim 0.08$ the change in the thermal conductivity on going over into the intermediate state, and consequently, the scattering of the phonons by the electrons, decreases to 50% when the temperature drops from 0.3 to 0.1°K. This is probably connected with the effect of the phonons "flying through" the normal region [1].

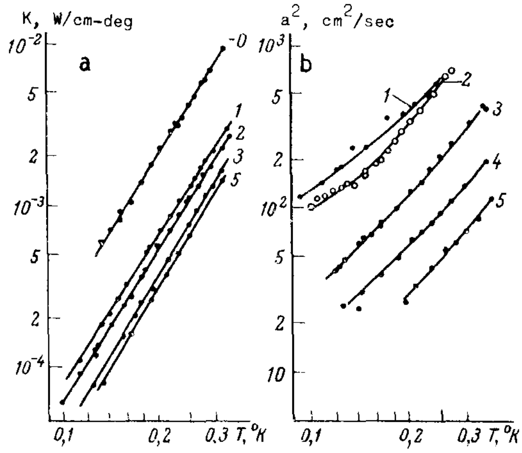


Fig. 1. a - Specific heat of the investigated sample, b - temperature conductivity of the investigated sample. The fraction of the normal phase in the sample is: 0 - $\eta = 0$ (superconducting state), 1, 2 - $\eta = 0.08$; 3 - $\eta = 0.15$; 4 - $\eta = 0.3$; 5 - $\eta = 0.45$.

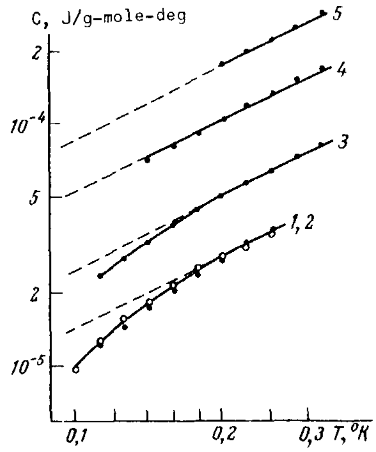


Fig. 2. Specific heat of tin in the intermediate state for different fractions of the normal phase (the notation is the same as in Fig. 1b; the dashed lines represent $C_n = \alpha(\eta)T$.

The temperature conductivity $a^2$ was measured from the attenuation of the temperature wave propagating along the sample with frequency 9.2 cps. At this frequency, the attenuation of the wave in the superconducting state did not exceed 1%, according to [1], and we therefore measured in the experiment the relative change in the attenuation when the sample in the magnetic field passed from the superconducting into the intermediate state. This procedure increased the accuracy of all the measurements greatly. The value of $a^2$ was determined in the range from 20 to 600 $cm^2$/sec. The lower limit is connected with measurement difficulties arising when the temperature wave between the thermometers attenuates by a factor greater than 30, and the upper limit is connected with the start of the influence of the wave reflected from the end of the sample [4]. The sample was 10 cm long. The measuring thermometers were located near that end of the sample which was in contact with the cooling salt. The distance between them was 3 cm.

The results of the measurement of $a^2$ are shown in Fig. 1c.

The specific heat of the investigated sample was calculated from the curves of Fig. 1. As can be seen from Fig. 2, at temperatures above 0.15°K, the specific heat in the intermediate state changes in proportion to the temperature, $C_n = \alpha(\eta)T$, regardless of what fraction $\eta$ of the sample is in the normal phase. This variation of $C_n(T)$ is to be expected in the absence of quantization of the energy levels, since both the specific heat of the lattice and the specific heat connected with the change in the magnetic energy are negligibly small at the investigated temperatures and magnetic fields. In the region of lower temperatures, deviations from the law $C_n = \alpha(\eta)T$ are observed, and are more strongly pronounced the smaller the fraction of the sample in the normal phase. According to [3], a similar character of the variation of the specific heat offers evidence of the appearance of quantization of the energy levels of the electronic excitations. The difference by almost a factor of 2 between $T_0 = \epsilon_0/k$ and the temperature with which the deviations from the $C_n = \alpha(\eta)T$ appear can be readily related to the form of the electronic excitation spectrum [3].

Thus, the measurements made in the region 0.1 - 0.15°K showed that the specific heat of a superconductor decreases in the intermediate state. Although this decrease is only 2 - 3 times larger than the possible experimental error, it can be related to the quantization of the energy levels of the electronic excitations considered by Andreev [3].

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## THREE-PHOTON MOLECULAR SCATTERING OF LIGHT

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The subject of this note is an estimate of the cross sections of three-photon Rayleigh and Raman scattering of light in gases and liquids. A study of such scattering yields information on the nonlinear properties of individual molecules (we recall that the known experiments on the observation of coherent three-photon processes in solids provide data on the nonlinear properties of a dielectric medium as a whole). We present below the probabilities of three-photon processes calculated by perturbation theory; an interesting result of our ana-