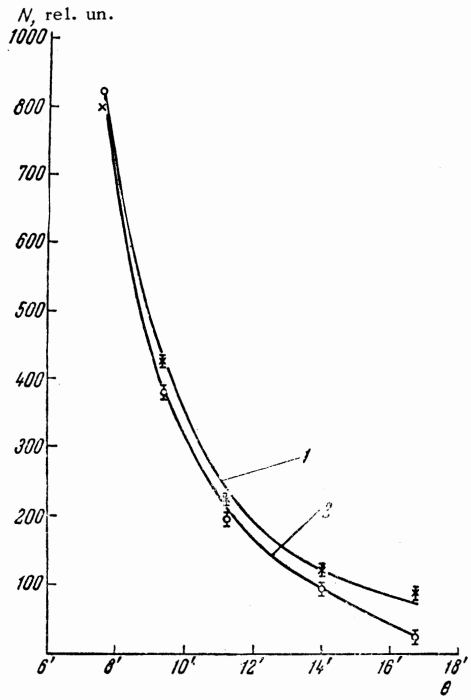

FIG. 2. Number of neutrons (per second) scattered with spin flip: 1 – Direction of the spin of the incident neutrons coincides with the direction of the magnetic field, 2 – direction of the incident-neutron spin opposite the direction of the magnetic field. When $\theta = 5.6'$ we get $N_1 = 4200$ and $N_2 = 3285$.

tion of corrections for the transmitted beam greatly reduces the accuracy of the results. The measurements were made up to angles 20′: at larger angles the low counting rate makes it practically impossible to determine the polarization.

It follows from the experimental results that the cross section for the scattering of neutrons with excitation of spin waves is not equal to the cross section for scattering with absorption of spin waves, and that with increasing scattering angle the absorption predominates over the excitation. These data are in agreement with calculations made by S. V. Maleev.

Calculations have shown that for a sample situated in a magnetic field H, scattering of neutrons with excitation of a spin wave should terminate at angles $\theta_+ < \theta_0$, while scattering with absorption of a spin wave at angles $\theta_- > \theta_0$. The parameter determining the angles θ_+ and θ_- is the quantity $2\mu_0 H/E$, where E—energy of the incident neutrons. Polarization on the order of 20% was observed when the samples scattered an unpolarized neutron beam at angles 10′—20′.

We have thus been able to show that neutron scattering by spin waves is actually accompanied by spin flip of the neutron and that the character of the scattering depends on the parameter $2\mu_0 H/E$.

S. V. Maleev participated in a discussion of the work during all of its stages, and we are most grateful to him for valuable advice. The authors are thankful to D. M. Kaminker for continuous interest in the work and for a discussion.

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Translated by J. G. Adashko
334

CONCERNING SURFACE SUPERCONDUCTIVITY

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In an earlier communication[1] we called attention to the possible existence of surface superconductivity. We dealt primarily with the transition into the superconducting state of electrons on non-localized surface levels of the crystal (one can also conceive, however, of other types of surface superconductivity and of surface ordering in general[1,2]) 1). It was indicated in [1] that interaction with surface phonons can lead to additional attraction between the electrons located either near or on the surface. On the whole, however, the question of the sign of the interaction of energy between the surface electrons remained open.

The purpose of the present paper is to discuss one seemingly promising way of obtaining surface superconductors, which may even have a high critical transition temperature T_c. Namely, additional attraction between the surface electrons can be produced by depositing on the surface a dielectric film or a monomolecular layer of neutral atoms. This conclusion can be easily arrived at by an analysis similar to that used by Little[5] for organic chains.

Formal use of the BCS scheme[3] leads not only to three- and two-dimensional systems, but also to a one-dimensional system. This circumstance was, of course, noted in the analysis of the two-dimensional system undertaken in [1]. However, such a possibility was not mentioned in [1], since we knew of no existing conducting one-dimensional chain, and also because general considerations (see [6]) point to the absence of ordering and phase transitions in one-dimensional systems. Little[5] advanced the hypothesis that one-dimensional superconductivity can exist all the same. However, an analysis made by Ferrell [7] confirms fully the conclusion that one-dimensional superconductivity is impossible. Whereas the hope of producing organic superconducting chains is thus apparently unjustified 2), we regard another aspect of Little's paper as interesting and attractive. Namely, it is clear from this paper that when the conduction electrons interact with the neutral atoms, an additional attraction between the electrons themselves will be produced. Little's calculation is then entirely applicable to the case of interest to us, when the extraneous atoms are on the surface of a crystal possessing surface conductivity. The result of the calculation reduces to an estimate of the parameters of the well known formula of the BCS theory[3]: $kT_K = \hbar\omega \exp[-1/N(0)V]$. In the case of electron attraction due to the presence of extraneous neutral atoms (molecules) on the surface, the energy $\hbar\omega$ is of the order of the difference of the energy level of these atoms, i.e., of the order of 1 eV. For the example considered by Little, $N(0)V \approx 2/5$, and in general various estimates usually yield $N(0)V \sim 0.1-0.5$. Consequently $T_c \sim 10^2 - 10^4\,°K$.

It is probably difficult to count in practice on a very large value of T_c, since the interaction energy decreases rapidly as the atoms move farther away from the surface, and the effective value of $N(0)V$ is small.

In the presence of a dielectric coating, of course, a change takes place in the interaction not only between the electrons on the surface levels but also between the "volume" electrons in the layer under the surface. Thus, such a coating is of interest also from the point of view of the search for surface superconductivity connected with the existence of attraction between the electrons only near the surface of the metal[1].

It seems to us that a very wide field has been laid open to experimental searches of surface superconductivity, since introduction of acceptors and donors will make it possible to change the number of conduction electrons on the surface levels in the semiconductors, and the use of coatings (monomolecular layers) will lead to a change in interaction between the surface electrons both in this case and in the case of metals.

The author is grateful to A. A. Abrikosov, L. V. Keldysh, and D. A. Kirzhnits for a discussion of the question.

1)As is well known, an essential element of superconductivity microtheory [3] is the fact that for a degenerate gas an arbitrarily weak attraction between the particles leads to the formation of an energy gap. However, in two- and one-dimensional cases, unlike in the three-dimensional case, a bound state is produced in a system of two particles also for arbitrarily small attractions [4] (this circumstance was pointed out to the author, in connection with [1], by A. S. Kompaneets). Therefore, degeneracy may not be indispensable for the formation of a gap of the superconducting type in the spectrum of a many-particle two-dimensional system.

2)We are not touching here upon the possibility of a change in the situation by participation of side bonds, i.e., essentially by a transition to two- and three-dimensional organic systems.

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335