which prevents measurements of the ion-temperature distribution by this method on the periphery of the plasma filament.

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FEASIBILITY OF NONPHONON MECHANISM OF SUPERCONDUCTIVITY IN THE ALLOY Nb_3Sn

A.I. Golovashkin and G.P. Motulevich
P.N. Lebedev Physics Institute, USSR Academy of Sciences
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A number of superconducting alloys with a lattice of the A-15 type and having critical temperatures $T_c \sim 17 - 21°K$ much higher than T_c of pure metals have been discovered in the last few years [1]. To check on a possible connection between such high values of T_c and the nonphonon superconductivity mechanism, Hopfield [2] proposed to determine the sign of the effective Coulomb pseudopotential μ^*, using the Macmillan formula [3]

$$T_c = \frac{\Theta}{1{,}45} \exp\left\{ - \frac{1{,}04\,(1+\lambda)}{\lambda - \mu^*(1 + 0{,}62\,\lambda)} \right\} \qquad (1)$$

and the value of the electron-phonon interaction constant λ obtained from optical measurements in the infrared region of the spectrum (Θ is the Debye temperature).

The electron-phonon interaction constant can be expressed in terms of the electron-phonon collision frequency ν_{ep} [2, 4]

$$\lambda = \frac{\hbar}{2\pi} \, \frac{\nu_{ep}}{kT} \, . \qquad (2)$$

The frequency ν_{ep} should be determined here at temperatures $T \sim \Theta$, when ν_{ep} is proportional to T; k is Boltzmann's constant. ν_{ep} can be obtained in turn from optical measurements in the infrared [5]. In the presence of noticeable scattering of the electrons by impurities or defects, to determine ν_{ep} it is necessary to perform, besides the optical measurements, also measurements of the ratio of the residual resistance of the sample to the resistance at the temperature T, i.e., R_{res}/R. Owing to the presence of effects connected with the quantum character of the electron-photon interaction [6], the electron-phonon collision frequency ν_{ep}^{opt} obtained by the optical method is always larger than ν_{ep}.

In the case of interest to us, however (Nb_3Sn at room temperature), the difference $\nu_{ep}^{opt} - \nu_{ep}$ is not large, and will be neglected.

The value of λ for Nb_3Sn was determined earlier in [4]. The optical data employed there were those obtained in [7] for near-stoichiometric Nb-Sn alloys of unknown phase composition. We determined λ on the basis of later optical investigations of the intermetallic compound Nb_3Sn [8]. The Nb_3Sn samples were produced by sputtering in vacuum [9], thereby eliminating the production of a a distorted layer on the surface. Special x-ray investigations have demonstrated that the samples contained only the A-15 phase. The optical properties of the Nb_3Sn were measured in a wide spectral interval, 0.45 - 10 μ. In the reduction of the experimental data we took into account the long-wave bands of the interband transitions (these bands were disregarded in [4, 7]). The obtained effective electron-collision frequency was $\nu_{eff} = 1.85 \times 10^{14}$ sec^{-1}. The ratio of the room-temperature and residual resistances of the indicated sample was $R_r/R_{res} = 2.5$. Assuming that

$$\nu_{eff} = \nu_{ep} + \nu_{ed}, \tag{3}$$

$$\frac{\nu_{ed}}{\nu_{ep} + \nu_{ed}} = \frac{R_{res}}{R_r} \tag{4}$$

we obtain $\nu_{ep} = 1.1 \times 10^{14}$ sec^{-1} and $\lambda = 0.46$. Allowance for the difference between ν_{ep}^{opt} and ν_{ep} leads to an even smaller value of λ.

The smallness of λ cannot be attributed to the influence of the surface, since the optical method yields information on the properties of the sample from a depth on the order of the skin layer. For Nb_3Sn, this depth is 500 Å.

Returning to formula (1), we find that $\mu^* = -0.12$ at $\lambda = 0.46$ and $\Theta = 304$°K. This value of μ^* was obtained using relations (3) and (4), which imply satisfaction of the Matthiesen rule. However, even the assumption that $\nu_{ep} \simeq \nu_{eff}$ yields $\lambda = 0.77$ and $\mu^* = 0.0$.

The negative sign of μ^* may indicate that a nonphonon superconductivity mechanism also exists in Nb_3Sn. Another explanation may be that the phonon spectrum of Nb_3Sn undergoes a radical change following the structural transformation in the temperature region 30 - 40°K [10]. If the constant λ in the low-temperature phase is much larger than λ in the high-temperature phase, then the value of μ^* may turn out to be positive at $T < 30$°K. To obtain $\mu^* = 0.13$, however, we must have $\lambda = 1.12$ [3]. Such a radical change of λ can hardly be expected if it is recognized that the indicated structural transition changes the Nb_3Sn lattice insignificantly. The value of the change in the electron-phonon interaction constant can be determined experimentally by measuring λ by an optical method at temperatures both below and above the structural-transition temperature.

It should be noted that the Nb_3Sn alloy has a number of singularities that distinguish it from ordinary metals. Optical investigations [8] have shown that it contains two fundamental interband-conductivity bands located in the region $\hbar\omega = 0.1 - 0.2$ eV of very low frequencies. Tunnel investigations [11] have revealed the existence in this alloy of four energy gaps 2Δ with ratios $2\Delta/kT_c$ equal to 3.0, 1.4, 1.0, and 0.2. All these ratios are lower than the theoretical 3.5. In our opinion, the smallness of the superconducting energy gaps may be connected with the smallness of the electron-phonon interaction constant λ. One of these gaps is anomalously small. The phonon spectrum of Nb_3Sn has a sharp state-density peak at 6 - 7 meV [12]. This is smaller by a factor 2.5 - 3 than the energy corresponding to the maximum of the transverse phonons of

Nb [3]. Finally, the temperature dependence of the static resistance of Nb$_3$Sn contains a term proportional to $\exp(-T_0/T)$, where $T_0 \approx 80$°K, a term nonexistent for other metals [9, 13].

All these features show that the electron and phonon spectra of Nb$_3$Sn are unusual and call for great caution when theories developed for ordinary metals are used.

In conclusion we are grateful to V.L. Ginzburg and to the participants of the seminar under his direction for a discussion of this work.

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EXPERIMENTS ON THE CONTAINMENT OF AN ALKALI PLASMA IN A CORRUGATED MAGNETIC FIELD

G.I. Budker, V.V. Danikov, E.P. Kruglyakov, D.D. Ryutov, and E.V. Shun'ko
Nuclear Physics Institute, Siberian Division, USSR Academy of Sciences
Submitted 25 December 1972
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As shown in [1, 2], longitudinal containment of a dense plasma (i.e., a plasma with $\lambda < L$, where λ is the Coulomb mean free path and L is the length of the apparatus) can be greatly improved by replacing the homogeneous magnetic field by a corrugated (multiple-mirror) field. We report here the results of experiments performed to verify the plasma-containment efficiency in such a magnetic-field configuration.