It has thus been found that for an entire series of TR ions (especially for the first half of the series), the spectra of the low-temperature thermal emission, attributed in [3] to the emission from cubic sites only, are non-elementary and are due to the emission from several optical TR^{3+} centers that take effective part in the recombination processes.

One can hope that, jointly with other methods of investigating multi-center systems, the procedure considered here for the study of radiation-stimulated emission will make it possible also to identify a number of hitherto uninvestigated activator centers.

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THERMOELECTRIC POWER OF ALUMINUM IN STRONG MAGNETIC FIELDS AT LOW TEMPERATURES

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Of all the transport phenomena, the Seebeck effect is among the most sensitive to external influences and to the energy state of the electrons in metals [1 - 3]. Investigations of the influence of strong magnetic fields on the thermoelectric power can yield information on the energy spectrum of the metal and reveal the roles and values of the thermoelectric-power components due to the distribution function of the electron energies and to electron-phonon interaction.

There have been no prior investigations of the influence of magnetic fields on the magnitude, sign, and anisotropy of the thermoelectric power of aluminum. There have been a few studies [4, 5] of only the temperature dependence of the thermoelectric powers of polycrystalline samples.

We have undertaken a study of the influence of a constant magnetic field of intensity up to 50 kOe on the anisotropy and the temperature dependence of the thermoelectric power of aluminum in the 5.4 - 79°K range. The object of the investigation was a single crystal measuring 3 × 4 × 60 mm, cut from an ingot. After preparation and mounting in the calorimeter, the ratio R(273°K)/R(4.2°K) of the sample was $\sim$6000. The same sample was used earlier to measure the thermal conductivity in strong magnetic fields [6].

The investigation procedure was similar to that described in [6, 7]. The temperature gradient over the working length of the sample ranged during the experiment from 0.15°K at low temperatures to 1.2°K at high ones. The measurements were made in steps of 1 - 2°K. The thermoelectric power was determined from three points corresponding to different values of the gradient, the cold-junction temperature being kept constant. The measurement error was ±0.025 μV/deg.

The anisotropy of the thermoelectric power of aluminum was determined at 9.6 and 49.3°K. The measurements were made in a 50-kOe transverse magnetic field with the sample rotated about its long axis in steps of 5°. The field intensity vector was in the (110) plane during the experiment.

The polar diagram of the anisotropy of the thermoelectric power of aluminum, as a function of the angle between the directions of the crystallographic axes and the magnetic field vector, is shown in Fig. 1.

As seen from the figure, at 9.6°K one can separate distinctly the anisotropic part of the thermoelectric power, which varies strongly with the sample rotation angles, from an almost isotropic part fluctuating in the range 0.15 - 0.35 μV/deg. The sharp maxima ranging from 0.58 to 0.66 μV/deg, appear when the plane of the electron orbits in the magnetic field coincides with the crystal directions $[1\bar{1}0]$, $[\bar{1}14]$, and $[1\bar{1}4]$, which lie in the (110) plane.

This confirms the high sensitivity of the thermoelectric power in a magnetic field to the reciprocal-lattice structure and to the position of the Fermi surface [3].

A study of the field dependences in directions corresponding to the maximum and minimum of the thermoelectric power has shown that they differ at 9.6°K, starting with a magnetic field intensity $H_{\perp} \sim 40$ kOe and higher (right-hand side of Fig. 2). After $H_{\perp} \sim 40$ kOe is reached, an appreciable growth of the thermoelectric power is observed in the direction of the maximum ($\phi \approx 30°$), due apparently to magnetic breakdown. There is no such increase of the thermoelectric power in the minimum direction ($\phi = 0°$) up to $H_{\perp} = 50$ kOe. Nor was such a phenomenon observed in either direction at 49.3°K in fields up to 50 kOe.

To refine the observed effect, we measured the temperature dependences of the thermoelectric power in the absence of a magnetic field (α) and its value in a field (α_H) $H_{\perp} = 50$ kOe for both directions ($\phi = 0°$ and $\phi \approx 30°$). The temperature dependence plotted in a magnetic field in the interval 7.8 - 9.6°K shows at $\phi \sim 30°$ an abrupt decrease of the thermoelectric power, followed by an increase with further increase of the temperature (left-hand side of Fig. 2). No such variation was observed in the temperature dependence of the thermoelectric power in the $\phi = 0°$ direction and in the indicated temperature interval.

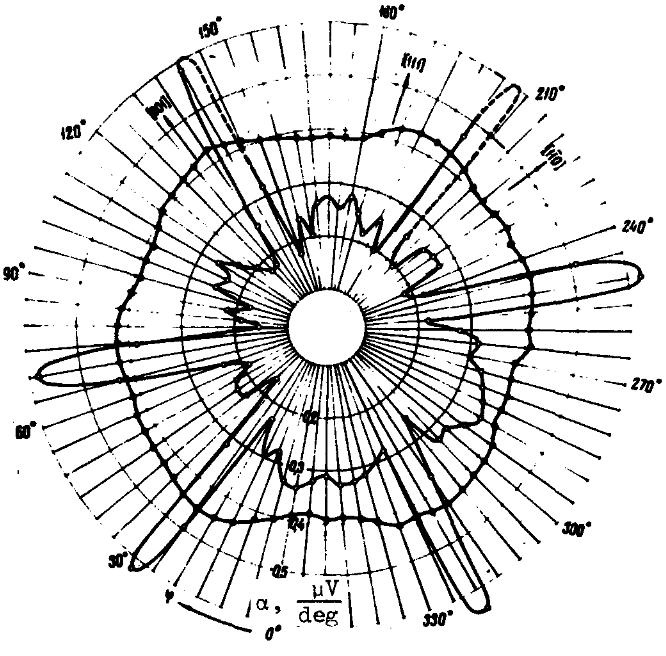

Fig. 1. Anisotropy of the thermoelectric power of an aluminum single crystal in a magnetic field H = 50 kOe: o - T = 9.6°K, ● - T = 49.3°K.

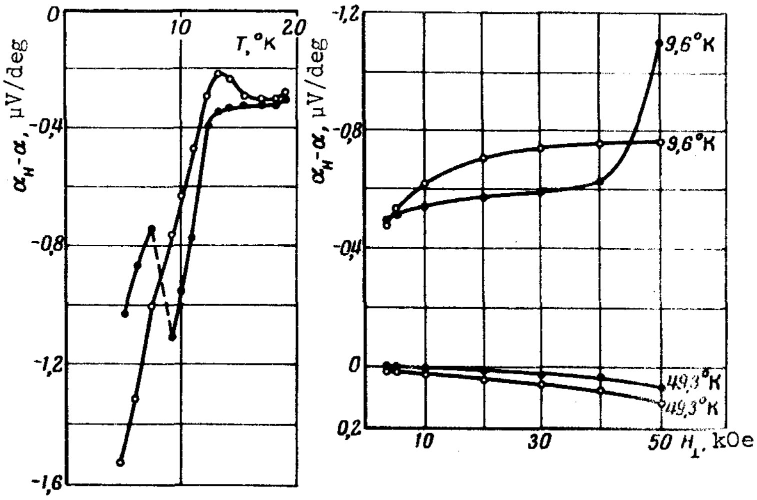

Fig. 2. Plots of $\alpha_H - \alpha$ vs. the temperature (left-hand side) and vs. the magnetic field intensity (right-hand side) for single-crystal aluminum in the directions $\phi = 0°$ (o) and $\phi = 30°$ (●).

The drop in the thermoelectric power, observed at 9.6°K in the $\phi \simeq 30°$ direction, may be connected with magnetic breakdown [9]. According to the experimental data, the width $\Delta\varepsilon$ of the energy gap, obtained from the temperature dependence of $\alpha_H - \alpha$, is of the order of $\sim 3.5 \times 10^{-4}$ eV, which is close to the values determined in [8].

Investigation of the anisotropy of the thermoelectric power at low temperatures in strong magnetic fields apparently uncovers wide possibilities for the study of the band structure of metals.

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CARRIER DRIFT IN LIQUID NEON AND ARGON

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The development of electronic methods for the detection of ionizing-particle tracks in liquid dielectrics (cf., e.g., our papers [1]) raises the question of the liquids in which free electrons can exist.

It has been established so far that free electrons are capable of moving in an electric field, with mobility $\sim 10^2 - 10^3$ cm^2/V-sec, through layers of heavy liquefied noble gases (argon, krypton, xenon) and of certain organic liquids [2, 3]. In many nuclear-physics problems it is important to use light