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1) If the Universe was cold at the initial instant, the number of quarks should be appreciably smaller. However, the recently observed relict radio emission is evidence in favor of the hot model.

CHARACTER OF CONDUCTION-ELECTRON REFLECTION FROM THE SURFACE OF COPPER WHISKERS

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It has been assumed until recently, on the basis of experimental data on both the conductivity of thin polycrystalline samples (foils, wires, films) and the anomalous skin effect, that practically all the electrons that participate in charge transport in real samples are scattered diffusely by the surface [1-4].

It has been observed lately, however, that specular reflection of the electrons from the surface plays an important role in the conductivity of a number of objects [5-10]. The conditions under which this phenomenon takes place have not yet been thoroughly studied.

The objects used in the present work to study the character of reflection of conduction electrons were single-crystal copper whiskers having small dimensions and a natural crystallographic faceting. This obviously should contribute to specular reflection or to regular diffraction of the electrons on the surface, the possibility of which should be taken into account for electrons with wavelengths smaller than the period of the distribution of the atoms on the crystal face.

The single-crystal whiskers were obtained by reducing spectrally-pure copper iodide in a hydrogen stream at 610 - 620°C [11]. They were produced with three crystallographic orientations ([100] with square cross section, [110] with rectangular section, and [111] with hexagonal section).

We selected for the investigations, using a microscope, straight, elastic single-crystal whiskers of uniform thickness, having different diameters and optically smooth surfaces with cross sections that were either hexagonal or differed little from square. Each investigated sample was placed between four single-crystal whiskers which acted like springs and served as current and voltage leads. The dielectric oxide layer at the contact points was broken down with a voltage of 300 V applied to the contact through a resistance of $\sim 10^6$ ohms. The electric contacts obtained in this manner were sufficiently reliable. The length of the sample between contacts was measured with a microscope. The average cross section area (s) was determined from the resistance at room temperature, the diameter was assumed equal to $\sqrt{s}$, and ρ_{room} was assumed equal to 1.68×10^{-6} ohm-cm. The sample resistance was measured at room and helium temperatures with a potentiometer circuit. The value of ρ at 4.2°K was determined from the relation

$$\rho_{4.2°K}/\rho_{room} = R_{4.2°K}/R_{room}.$$

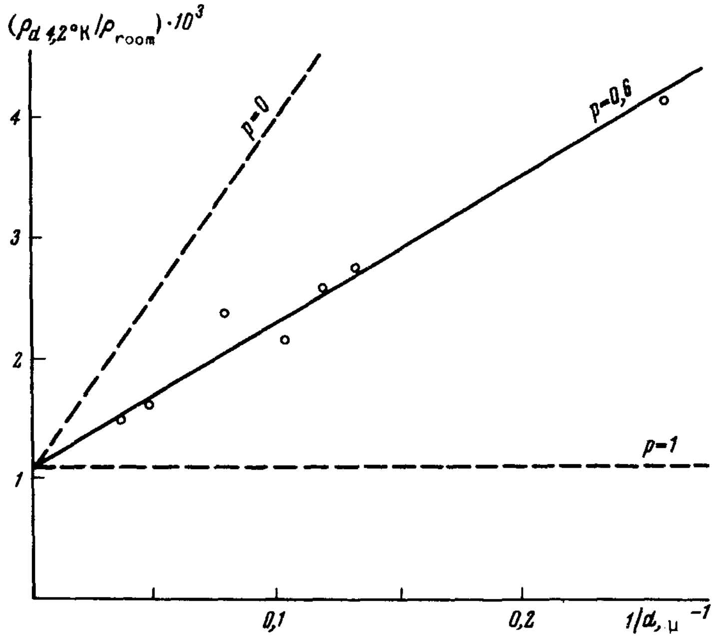
A large scatter was observed in the values of $\rho_{4.2°K}$ of the whiskers, probably connected with the variation of the amount of impurities in the single crystals. In spite of this, the preliminary data we obtained for whiskers of the purest batch make it possible to draw certain sufficiently reliable conclusions concerning the character of reflection of the electrons from the faces of the single crystals.

To interpret the experimental data, we use the simplest theory of conductivity of thin samples of metals having a spherical Fermi surface [12]. For copper, whose Fermi surface has the form of slightly distorted spheres interconnected by relatively thin bridges, this theory should be approximately valid. According to this theory, the value of ρ of thick metal wires ($d \gg \lambda$) is given by

$$\rho_d = \rho_\infty[1 + C(1 - p)\lambda/d], \qquad (1)$$

where ρ_∞ is the resistivity of the bulky sample, λ the electron mean free path in the bulky sample, p a parameter denoting the fraction of the electrons specularly reflected from the surface, and C a constant equal to 3/4 when $d \gg \lambda$. Thus ρ_d is a linear function of 1/d. Comparison with numerical calculations made by Sonheimer in a wide interval of values of d/λ (see [12], Table 2) shows that formula (1) can be used also at lower values, $d \sim 0.1\lambda$, and the coefficient C depends little on p, with $C = 0.8$ near $p = 0.5$ ($C \cong 1$ at $p = 0$).

The figure shows a plot of $\rho_{4.2°K}/\rho_{room}$ vs. 1/d at T = 4.2°K for the seven purest whiskers. Linear extrapolation of our data to $1/d = 0$ yields $\rho_\infty = 1.9 \times 10^{-9}$ ohm-cm at T = 4.2°K. Assuming for copper the value $\rho\lambda = 0.65 \times 10^{-11}$ ohm-cm^2, given by Chambers, which is in good agreement with the value of $\rho\lambda$ obtained from the free-electron model ($\rho\lambda = 0.63 \times 10^{-11}$ ohm-cm^2), we find that the mean free path of the conduction electrons in a bulky sample with the indicated value of ρ_∞ is 34 μ. Thus, the investigated samples had dimensions ($d = 3.85 - 20\ \mu$) smaller than or of the order of the mean free path of the conduction electrons. Comparing the experimental data with relation (1) at $C = 0.8$ we find that $p = 0.6$, i.e., 60% of the conduction electrons are reflected from the surface specularly. For comparison, the figure shows a plot of $\rho_{4.2°K}/\rho_{room}$ vs. 1/d for total specular ($p = 1$) and total diffuse ($p = 0$) reflection of the electrons from the surface of samples of the same purity (dashed lines).



The presence of partial specular reflection can also be demonstrated without assuming uniform purity of the investigated whiskers. For the thinnest of the investigated samples ($d = 3.85\ \mu$) we get from (1)

$$\rho_d \geq 0.8\rho_\infty(1 - p)\lambda/d.$$

Consequently,

$$p \geq 1 - 1.25\,\frac{\rho_d d}{\rho_\infty \lambda}\ . \tag{2}$$

Substituting in (2) $\rho\lambda = 0.65 \times 10^{-11}$ ohm-cm^2 and $\rho_d = 6.1 \times 10^{-9}$ ohm-cm, we get $p = 0.47$.

It is possible that when the experimental conditions are improved the specular reflection of the electrons from the surface of single-crystal whiskers can be made more complete. In particular, it would be advantageous to eliminate the possibility of oxidation of the sample surface in air.

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MOSSBAUER EFFECT ON Fe^{57} IMPURITY NUCLEI IN $MnAu_2$

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1. The compound $MnAu_2$ has attracted the attention of many investigators. $MnAu_2$ is a helicoidal antiferromagnet with a Neel point at 90°C [1] (according to Karchevskii and Nikolaev [2], $T_N = 100$°C). Its magnetic structure can be destroyed by a sufficiently strong external magnetic field. $MnAu_2$ affords the rare opportunity of investigating the properties of a substance both in the antiferromagnetic and in the ferromagnetic state at the same temperature.

Bearing this circumstance in mind, we have undertaken an investigation of the Mossbauer effect on Fe^{57} impurity nuclei in the crystal lattice of $MnAu_2$. The purpose was, in particular, to ascertain how the transition of a substance to the ferromagnetic state affects the magnitude of the magnetic field acting on the nucleus of the impurity atom. Particular attention was paid to the behavior of the Mossbauer-effect probability in magnetic transformation.

2. The Mossbauer-effect experiments were made on a sample previously used to investigate the temperature dependence of the magnetic properties [3,4]. The $MnAu_2$ sample (in the form of a disc 18 mm in diameter and about 1 mm thick) was used as the radiation source. The atoms of the isotope Co^{57} (which decays to the isomer Fe^{57m}) were introduced into the $MnAu_2$ lattice by diffusion at 690°C for six hours in a hydrogen atmosphere. The sample was quenched after the end of the annealing.

The absorber in the Mossbauer-effect experiments was a stainless-steel foil (70% Fe). The measurements were made with apparatus of the cam and of the electodynamic type. The Mossbauer spectra were measured in the interval from 20 to 180°C. Experiments were also made at room temperature in an external magnetic field of intensity up to 18 kOe. In these experiments, the sample was placed in a field perpendicular to the direction of emission of the registered γ quanta, while the absorber, together with the photomultiplier, was placed in the magnetic-shielding block.

3. The results were somewhat unexpected. Figure 1 shows some of the spectra measured in the absence of an external field. As seen from the figure, no clear-cut Zeeman splitting of the spectral line is observed at room temperature ($T/T_N \simeq 0.8$). According to our estimate,