In the first approximation, the ratio θ_m^2/θ_0^2 characterizes the ratio of the force constants ($\gamma = m\theta^2$, where m is the mass of the oscillating ion and γ is the force constant) in the magnetic and paramagnetic temperature regions.

We determined the ratios θ_m^2/θ_0^2 from the data in the table. They turned out to be the same for the two investigated iron garnets, 1.35 ± 0.06. From the θ_m^2/θ_0^2 ratio we determined the magnetic contribution $\overline{x_m^2}$ to the rms displacement of the Fe^{57} nuclei, $\overline{x_m^2} = 0.75\,\overline{x_0^2}$, i.e., the magnetic contribution to the rms displacements of the Fe^{57} nuclei amount, on the average, to 0.75 of the ordinary rms displacements of the iron ions in the paramagnetic temperature region. This estimate agrees well with the data of [8].

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NATURE OF THE ELECTRIC CONDUCTIVITY OF METALS IN THE TRANSCRITICAL STATE

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Submitted 16 July 1971
ZhETF Pis. Red. 14, No. 5, 295 - 298 (5 September 1971)

Recent papers report the measurement of the electric conductivity and of the equation of state of mercury [1 - 3] and cesium [4 - 9] at temperatures and pressures exceeding the critical values. The lack of information on the microstructure of matter in the transcritical state has made it difficult to understand the nature of the electric conductivity. On the basis of the experimental data, the transcritical state can be arbitrarily divided into three regions, in which the microstructure differs significantly [8, 10]. In the first region ($\rho > \rho_{crit}$) the dominant structure is the one characteristic of liquid metals, and therefore the electric conductivity in this region obeys laws governing liquid metals. In the next region the local density fluctuations increase to such an extent that ions falling in the rarefaction zone produce local force centers, and the conduction electrons are captured by these centers. As a result, the concentration of the conduction electrons is greatly reduced. In the upper limit, the metallic conductivity vanishes. The third region ($\rho < \rho_{crit}$) is one with an electric conductivity characteristic of dense ionized gases. It can be described by the methods developed for a dense plasma [11, 12].

To investigate the structure changes occurring when the density of a metal is decreased, an attempt was made to use as the first approximation an obviously oversimplified mechanical model. The real atoms were replaced by metallic spheres set in disordered ("thermal") motion by a special vibrating stand. The lowering of the real density was simulated by decreasing the number of spheres in a given volume. At the same time, the electric conductivity

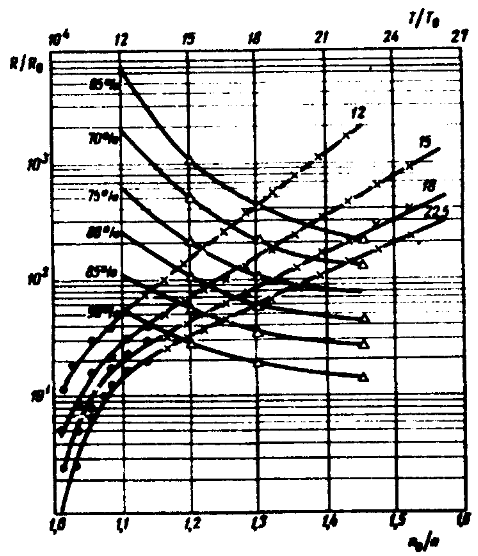

Fig. 1. Dependence of the relative electric resistance of a system of metallic spheres on their concentration and "temperature."

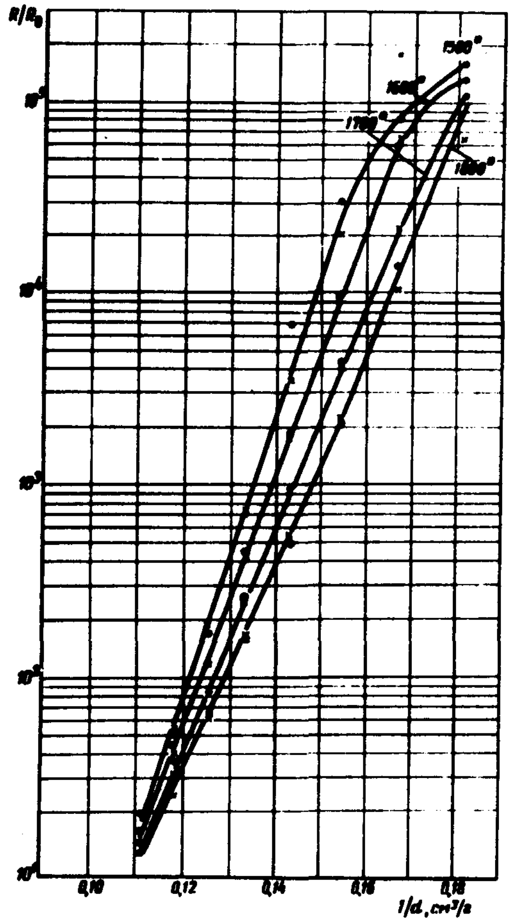

Fig. 2. Relative electric resistance of mercury vs. the density.

of the system was measured in an insulating tube with electrodes on the ends. By opening for a short time a small aperture in the end of the cylinder, it was possible to determine the mean free path of the sphere and their velocity distribution and hence, at a fixed density, the "temperature" of the spheres. The total number of spheres in the system was 1000.

Figure 1 shows plots of the electric resistance against the reciprocal density for different sphere "temperatures" T and against the temperature at constant concentration. These results can be represented by the formula

$$R = R_0 \exp\left(\frac{A}{\rho} - \frac{B}{T^{5/2}} + \frac{C}{\rho T^{5/2}}\right), \tag{1}$$

where A, B, and C are constant coefficients (the conductivity is due to the formation of conducting chains). This formula also describes well the electric conductivity of mercury. The points on Fig. 2 represent the experimental data on mercury [3], and the crosses the values of the resistance calculated from formula (1).

We do not consider this agreement to be accidental. It shows that the smooth variation of the electric conductivity with the density can be explained without making use of the collective effect of interelectron correlation. At low densities the resistance of the system of spheres becomes infinite, whereas in the case of mercury the character of the dependence of the resistance on the density changes. This can be attributed to the fact that plasma conductivity begins to prevail.

We thus have two clear-cut limits. The first corresponds to the change of the temperature coefficient of resistivity of mercury at a density near 9 g/cm^3 [3]. It can be called the "close-packing" limit. This limit can be traced also in the case of a system of spheres (see Fig. 1). The second limit can be called the "limit of metallic conductivity." Starting with this limit, a rise in temperature produces no chains through which metallic conductivity can be effected. The arbitrary transition boundary shifts on approaching the limit. Near the critical density, a shift towards lower densities and a rise in temperature are observed. The transition line crosses the critical isobar of the metal-dielectric transition only at the critical point, and does not go along the isobar as stated in [13]. The foregoing results lead to important conclusions concerning the characteristic dimension of the atom and the limiting possibilities of chemical bonds.

The author thanks A.M. Dykhne and L.V. Keldysh for numerous useful discussions.

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INFLUENCE OF REACTOR IRRADIATION AT HELIUM TEMPERATURE ON THE PINNING OF ABRIKOSOV FLUXOIDS IN SINGLE-CRYSTAL NIOBIUM

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Submitted 19 July 1971
ZhETF Pis. Red. 14, No. 5, 299 - 301 (5 September 1971)

It is known that Abrikosov fluxoids are pinned on different crystal-lattice defects. An important role in this pinning is played by dislocation. The pinning force is estimated in [1 - 3]. The influence of the dislocation density on the pinning was estimated in a theoretical paper by Baramidze and Saralidze [4], and the influence of surface defects of the crystal on the pinning of magnetic vortices was estimated in an experimental study by the present authors jointly with D.G. Chigvinadze and a group from Oxford [5, 6]. The influence of low-temperature neutron irradiation on dissipative phenomena in the mixed state was investigated by Andronikashvili et al. [7].

Using the currentless procedure developed at the Physics Institute of the Georgian Academy of Sciences (described in detail in [5, 6]), we investigated