probably the most effective source is the magnetic field of the earth. In order to be scattered considerably a particle must approach the earth so closely that its radius of curvature, ρ, in the terrestrial magnetic field, H, is of the same order as the distance R to the earth's magnetic dipole (moment $=A$). If P is the momentum of the particle we have

$$R \approx \rho = P/H \approx PR^3/A,$$

or

$$R^2 \approx A/P.$$

For $P=10^7$ gauss-cm (corresponding to $3\cdot 10^9$ ev for electrons), and with $A=8\cdot 10^{25}$ gauss-cm^3, we find for the scattering cross sections of the terrestrial magnetic field

$$S=\pi R^2 = 2.5\cdot 10^{19}\ \text{cm}^2.$$

If cosmic radiation is leaking with the velocity c through this "hole" in the screen of the solar magnetic field, the volume τ inside the "screen" will be filled after the time

$$T=\tau/Sc.$$

Putting $\tau \approx r^3$ (r = orbital radius of the earth) we find

$$T=0.5\cdot 10^{10}\ \text{sec}.$$

The number of particles in the periodic orbits is determined by the absorption in interplanetary matter during this time. If the density is ρ g/cm^3, the matter which the radiation passes in the time T is $D=cT\rho=1.5\cdot 10^{20}\ \rho$ g/cm^2. According to Baumbach[6] the density in the outer corona is $\sim 10^{-19}$ g/cm^3, and in interplanetary space the density must be much less. Consequently D is probably less than 1 g/cm^2, so that the absorption is small.

This seems to indicate that for momenta above P_1 cosmic rays reach the earth from all directions. Below P_1 all directions are forbidden unless scattering by the outer planets or other causes cause some of the weaker radiation to leak in.

Hence theoretically the solar magnetic field is not likely to produce a diurnal variation. Through a study of the trajectories, Malmfors[7] has shown that the observed solar time variations cannot be due to the solar magnetic field.

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The Magnetic Threshold Curves of Superconductors

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IN a recent letter Stout[1] has ably summed up the evidence in favor of assuming that the magnetic threshold curves of superconductors are approximately parabolic functions of temperature, a suggestion that was put forward by Kok.[2] He has pointed out that a three-halves power function, as has been suggested recently by Sienko and Ogg,[3] cannot be supported by known magnetic or calorimetric data.

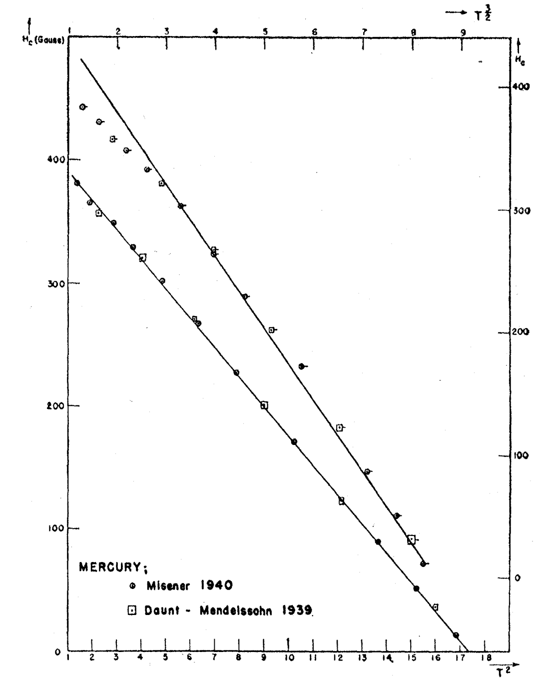

FIG. 1. The variation with temperature of the magnetic threshold of mercury.

As is well known, the magnetic transition of a superconductor is strongly dependent on small chemical or physical impurities. The significance of the latter effect has been emphasized recently by the experiments of Lasarew and Galkin[4] on tin specimens subjected to anisotropic stress. In view of these impurity effects, considerable care must be taken in assessing the magnetic measurements on various superconductors. Probably the material with the highest purity and smallest strain is mercury, as measured by Daunt and Mendelssohn[5] and by Misener,[6] the magnetic transition of which was found by these independent workers to agree within one percent. The temperature variation of the magnetic threshold field, H_c, in mercury, therefore, is given in Fig. 1. The lower curve plots H_c against T^2, which for a parabolic function should be a straight line. It will be seen that the measured points do not deviate from the straight line by more than ± 4 gausses, a variation which, for the higher fields, is probably covered by the experimental error. The upper curve shows H_c plotted against $T^{3/2}$, which according to Sienko and Ogg[3] should be a straight line. It will readily be seen that the deviations of the measured points from a straight line are too systematic and too large to be covered by experimental error.

Similar curves have also been drawn up for other superconductors and all show that the $T^{3/2}$ function is the more unsatisfactory.

The immediate significance that can be attached to an exact formulation of the magnetic threshold curve is twofold. First, it may lead to a satisfactory generalization for all superconductors. For the parabolic form, such a generalization has already been made by Kok[2] and by Daunt, Horseman, and Mendelssohn.[7] The result is that

$$H_0/T_c\gamma^{\frac{1}{2}}=(2\pi/V)^{\frac{1}{2}}, \tag{1}$$

where H_0 is the threshold field at $T=0$, T_c the transition temperature, V the atomic volume, and γ the Sommerfeld electronic specific heat term[8] of the normal state. This generalization seems to be in satisfactory agreement with experiment.

Secondly, an exact formulation of the threshold curves may lead to a method of assessing the variation with temperature of the number of electrons that can partake in superflow. Although in the absence of a satisfactory atomic theory of superconductivity the method to be adopted is not clear, some comment on recent experimental results may be of value. H. London,[9] from measurements on the depth on penetration, δ, of a magnetic field into a superconductor and on high frequency resistance, concluded that the number of electrons, n_s, partaking in superflow may be expressed as a power series in T, with a predominant term in T^2. The variation of n_s with T, as calculated from measurements of δ, however, is very sensitive to the assumed magnitude of δ at absolute zero; and, since the latter can only be estimated with difficulty, these results must be taken with reserve. Recent measurements by Désirant and Shoenberg[10] on δ for mercury allow a new evaluation of n_s to be made, if the relation between n_s and δ as given by the theory of F. and H. London[11] is assumed. Such an evaluation has been made by the writer, yielding a function in T^3, i.e.,

$$n_s=n_0[1-(T/T_c)^3], \tag{2}$$

where T_c is the transition temperature.

Owing to the divergent results quoted above, and to the somewhat arbitrary nature of the assumptions by which they have been deduced, one may conclude that more data are required. It has been pointed out elsewhere[12] that the threshold curves, giving the maximum current density permissible at any given temperature on the surface of a superconductor, are analogous to the rate-of-flow curve for superflow in helium II[13], and the hypothesis was put forward that they both represent the variation in the number of particles partaking in superflow. Such a hypothesis has received some support on theoretical grounds,[14] and in the case of helium II the recent measurement by Andronikashvilli[15] on the number of superfluid particles gives direct experimental support to it. It would be of value to have similar detailed experimental evidence for superconductivity.

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