trons, the diffusion process must be extended in time, i.e., the free path must somehow be increased. This can be done by reducing the density of the medium, i.e., by passing from condensed media to compressed gases. In this connection it is interesting to investigate the pressure dependence of the radiation intensity from the drifting electrons (sharp variation when $l_s \sim v/\omega$).

We wish to evaluate the number of quanta radiated by an electron during elastic collisions in a medium in which the conditions for radiation-pulse formation have been fulfilled for every scattering event; i.e., $l_s \gtrsim v/\omega$. When moderated, each electron radiates a number of quanta

$$\nu \approx \frac{r_0}{c} \varepsilon \frac{\Delta\omega}{\hbar\omega} \frac{M}{m} .$$

Assuming that $\Delta\omega/\omega \simeq 0.5$ and that the electron energy is $\epsilon \simeq 10$ ev and $M/m \approx 10^5$ (these last figures being characteristic for argon, for example), we obtain $\nu \simeq 10^{-2}$ quanta per drifting electron. The number of these drifting electrons formed by a single-charge relativistic particle per unit mass of track is $n_e \approx 10^4$ electrons/g, so that $\nu n_e \approx 10^2$ quanta/g; i.e., the radiation from the diffusing electrons comprises a significant part of the radiation of luminescence (on the order of one percent of the quantum yield of a good luminophor). Incidentally, in places where ionization and excitation are concentrated (e.g., along the tracks of secondary electrons or of other heavily-ionizing particles) there may be an additional energy transfer from the excited atoms to the drifting electrons because of collisions of the second kind.

The radiation discussed here, unlike luminescence radiation, has a continuous spectral distribution, i.e., it also exists in regions of the spectrum where there is little or no luminescence radiation. The emission time of this radiation, $\tau \sim l_s M/vm$, has nothing in common with the lifetime of the excited atoms and may be very much shorter than this lifetime. All this, and the sensitivity of the diffusion radiation to the addition of impurities that absorb free electrons and to variation in the density of the medium and other peculiarities, facilitates its differentiation even in regions of the spectrum where luminescence radiation is stronger.

Incidentally, the total radiated energy from each strong elastic scattering event can constitute a significant portion (on the order of one percent) of the energy transferred to the molecule.

The difference between the radiation effect discussed here and true luminescence should be apparent also when there are superimposed strong electric fields capable of compensating for the reduction of the energy of the drifting electrons in low-density media; thereby causing a sharp increase in scattering events and in the number of radiated quanta.

In some media, e.g., in inert elements, a sharp decrease occurs in the scattering cross section for an electron energy ~ 1 ev (the so-called Ramsauer effect). In crossing this energy range, the conditions for pulse formation for infrared frequencies may be fulfilled even in condensed media.

The discussed specific radiation processes can be used, for example, to analyze the stages and dynamics of electron behavior; to generate waves less than a millimeter long by exposing a substance to a beam of light, to a stream of ionizing particles, or to x rays from a powerful x-ray tube; to sort out the conditions needed for increasing the fast portion of the radiation created by a recorded particle, and for other practical applications.

[1] L. D. Landau and E. M. Lifshitz, Теория поля, Gostekhizdat (1948) p. 208. see English translation, L. Landau and E. Lifshitz, The Classical Theory of Fields, (Addison-Wesley Press, Cambridge, Mass., 1951) p. 197.

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OSCILLATOR DEPENDENCE OF THE SURFACE RESISTANCE OF A METAL ON A WEAK MAGNETIC FIELD

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THEORETICAL investigation of the dependence of surface resistance of a metal on a constant magnetic field applied to it leads to the conclusion that the surface resistance in a weak field must change monotonically with increasing field.[1,2] Measurements were carried out[3] which are in full agreement with these calculations. However, as shown by experiments some results of which are given in this letter, the dependence of the surface resistance of a metal on the magnetic field in regions of weak fields is not at all monotonic.

Measurements were carried out at a frequency of 9400 Mcs by the method of frequency modulation[4] on single crystals of tin of very high purity, with less than 6×10^{-5} per cent impurities (reference 5, tin No. 6). Tin, cadmium, and indium were also tested, with impurities $\sim 2 \times 10^{-3}$ per cent.

The single crystals were grown from the melt in a glass mold in the plates with dimensions $13 \times 6 \times 1$ mm. Such a plate serves as a strip-type resonator one-half wavelength long; the high-frequency currents flow along the plate.

A series of experiments were carried out with a single crystal prepared from very pure tin, with a tetragonal axis parallel to the middle dimension and the binary axes parallel to the other two dimensions. A record of the dependence of the field of the logarithmic derivative of the reactive surface impedance with respect to the field, $\xi = X^{-1}\, \partial X/\partial H$ is given in Fig. 1, where the constant field H is parallel to the high frequency magnetic field H_ω, i.e., it lies in the plane of the specimen perpendicular to its length. Rotation of H in the plane of the specimen leads to a decrease in the amplitude of oscillations of $\xi(H)$ and to their shift to higher fields. The oscillations die out as the field approaches $H \perp H_\omega$. The absolute values of the field H_n for which $\xi(H_n) = 0$, where n is an ordering number, increase as $H_n(0)/H_n(\alpha) = \cos\alpha$ when H is rotated by an angle α from the direction of H_ω. An arbitrary position of the vector H in the plane $\perp H_\omega$ does not give oscillations of $\xi(H)$; slanting of the direction of H outside of this plane makes it possible to observe the oscillations. It follows from this that the oscillations of ξ on a given specimen are brought about by the projection of H in the direction H_ω.

It is difficult to establish the law of periodicity of the observed oscillations because of their small number. However, the first four values of H_n (Figs. 1 and 2) satisfy the relation $H_{n+1}/H_n = 1.6 \pm 0.1$. A similar relation for four values of H_n obtained with cadmium yields $H_{n+1}/H_n = 2.1 \pm 0.2$. The same effect is also noted in indium. It should be noted that the periodicity of the oscillations is not a function of H^{-1}. Upon increase in the field $H \parallel H_\omega$ above 5 oe, a monotonic decrease is obtained for the quantity ξ which changes sign at $H \sim 20$ oe, and at $H \gtrsim 40$ oe begins to undergo oscillations which are periodic functions of H^{-1}, evidently corresponding to cyclotron resonance.[4]

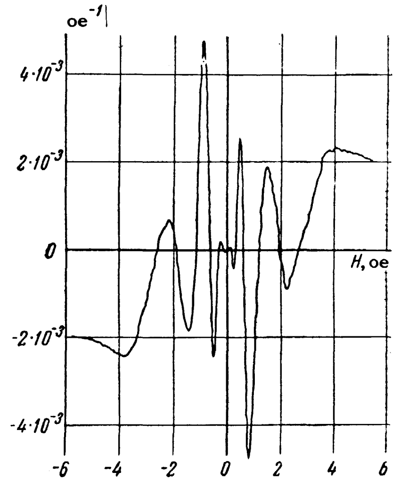

FIG. 1. Dependence of $\xi(H)$ for monocrystalline tin, obtained in a slow increase of the field from −6 to +6 oe. The noise in the recording is evident; the symmetry of the curve makes it possible to judge the reproducibility of the results of the experiment.

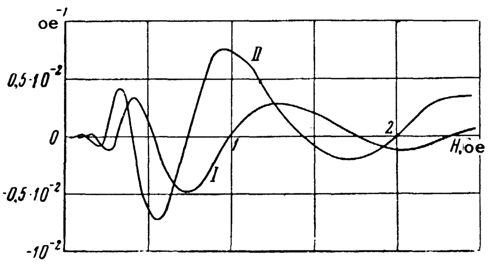

FIG. 2. Curve I is the function $\xi(H)$ and curve II is the dependence of $\xi(H) = 0.9R^{-1}\partial R/\partial H$ on H. The curves were obtained by the analysis of recordings similar to those of Fig. 1 (as the sum and difference of two experimental recordings).

Figure 2 shows the results of experiments for $H \parallel H_\omega$ on the field dependence of the logarithmic derivative of the reactive and active surface impedances with respect to the field. These experiments were carried out on a single crystal of tin. Within the accuracy of the experiment, curve II is proportional to the derivative of curve I with respect to the field.

The curves we have described were obtained at a specimen temperature of 3.8°K; heating to 4.2°K approximately halves the amplitude of the oscillations and increases somewhat the values of H_n. The oscillations disappear at ~ 10°K or somewhat higher. The transition of the specimen to the superconducting state leads to the vanishing of the effect. If the temperature of the specimen is a little less than critical, so that the critical magnetic field H_c is $\sim 1-3$ oe, then oscillations are not observed in the superconducting state of the specimen ($H < H_c$), but in the normal state they are the same as for 3.8°K.

The amplitude of the high frequency field H_ω in the resonator amounts to ~ 0.1 oe, i.e., of the same order of magnitude as H. However, decrease of H_ω by a factor of 10 has no effect on the observed phenomenon. The fact that the amplitude of H_ω changes from zero up to the maximum along the specimen, which is a strip of resonant length, also speaks in favor of the absence of a dependence of the effect on H_ω.

The observed effect is anisotropic. Both the location and the amplitude of the oscillations are different in specimens with other crystallographic orientations, but the general character of the phenomenon is preserved: some oscillations of $\xi(H)$ are observed in the region $H < 5$ oe, changing to a monotonic variation upon increase in H. The oscillations have a much smaller amplitude in less pure specimens. The effect is completely absent in controlled experiments with specimens made from polycrystalline copper of technical purity.

The physical reasons for the new phenomenon just described are still not clear. There is a basis for assuming that the oscillations of the surface impedance take place as the result of quantum oscillations of the magnetic susceptibility of the metal. In particular, the connection of this phenomenon with the magnetic properties of a metal is shown by the character of its dependence on the direction of the constant magnetic field. It is possible that the phenomenon described is related to the de Haas — van Alphen effect. However, it differs qualitatively from the latter by highly characteristic features: the oscillations of ξ are nonperiodic as functions of H^{-1}, their periods are very small in absolute value and large in relative value. Strictly, the entire resemblance between these two effects is limited to the nonmonotonic dependence of the magnetic susceptibility of the metal on the field.

It should be noted that the non-monotonic dependence of the surface impedance of the metal on the weak magnetic field is not only never observed experimentally, but also there do not exist theoretical calculations which would make it possible to predict or explain the nonlinear dependence of the surface impedance of the metal on the weak magnetic field, so strongly marked in the newly discovered phenomenon. The latter circumstance makes the further study of this phenomenon especially interesting.

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PROPERTIES OF THE AXIAL VECTOR INTERACTION AND THE DECAY $\Sigma \to \Lambda + e + \nu$

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FEYNMAN, Gell-Mann, and Levy[1] have shown recently that, if one postulates

$$\partial_\alpha j_\alpha = G f m^2 \pi, \quad (1)$$

for the divergence of the axial vector describing the strangeness conserving current j, the relation*

$$f = \sqrt{2}\, M G_A / gG \quad (2)$$

follows without any further assumptions.

Here π is the operator of the π meson field, g is the coupling constant for the strong interaction of the π mesons with the nucleons ($g^2/4\pi \approx 14$), $G = 10^{-5} M^{-2}$ is the universal constant of the weak interaction, G_A is the axial vector coupling constant of β decay ($G_A \approx 1.25\, G$), and the lifetime of the π meson, τ, is given in terms of f in the following fashion (see, for example, the author's review article[2]):

$$1/\tau = (G^2/8\pi) f^2 m^2 \mu^2 (1 - \mu^2/m^2)^2, \quad (3)$$

M, m, and μ are the mass of the nucleon, the π meson, and the μ meson, respectively. It follows from the comparison of formula (3) with experiment that $f \approx m$. This implies that relation (2) is satisfied with an accuracy of about 15%.

The condition (1), which was first considered by Polkinghorne,[4] requires very special assumptions about the form of both the strong and weak interactions.[1,4-6]† It is therefore desirable to derive other consequences, besides relation (2), from the hypothesis (1).

The aim of this letter is to show that the hypothesis (1) can be verified in an independent