for N_1 both the monomolecular reaction with the characteristic time τ_1 and the bimolecular reaction with constant γ_1. For N_2 we confine ourselves to the monomolecular reaction with lifetime τ_2. Under these assumptions, the concentrations N_1 and N_2 are readily expressed in terms of the aforementioned coefficients. Using the formulas of [6], we obtain the following expression for the dependence of N_b on I:

$$N_b = \frac{A\alpha_2 \tau\tau_2}{2\gamma_1\tau_1}\left(\sqrt{1 + 4\alpha_1\gamma_1\tau_1^2 I} - 1\right)I. \qquad (2)$$

The coefficients α_i in the kinetic equation determine the rate of excitation of the excitons of type i.

At low light intensities I, when the radicand in (2) is close to unity, we obtain a quadratic dependence of N_b on I. With increasing I, this dependence goes over into the relation

$$N_b = \text{const}\ I^{3/2}. \qquad (3)$$

As shown in [7], the intensity of the luminescence of the biexciton in CuCl at low power of the exciting radiation is proportional to the square of the light intensity. At high excitation intensities, the growth of the luminescence quantum yield decreases. The data of [7] for the CuCl crystal agree with the dependence of the luminescence on the light intensity predicted by formula (2).

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CONCERNING MAGNETIC BREAKDOWN IN BERYLLIUM

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Magnetic breakdown in beryllium observed back in 1963 [1], has been the subject of relatively many investigations. As is well known, breakdown causes giant oscillations to appear on the magnetoresistance curves of beryllium, if the field is parallel to the hexagonal axis [2]. A study of the nature of these oscillations is of considerable interest, since it yields additional information on the dynamics of electrons in the metal.

We have investigated the temperature dependence of the magnetoresistance-oscillation amplitudes in a wide temperature interval, using beryllium samples with $\rho(300°K)/\rho(4.2°K) \sim 150$. The measurements were performed in the field of a superconducting solenoid. In a number of cases, permendur concentrators were

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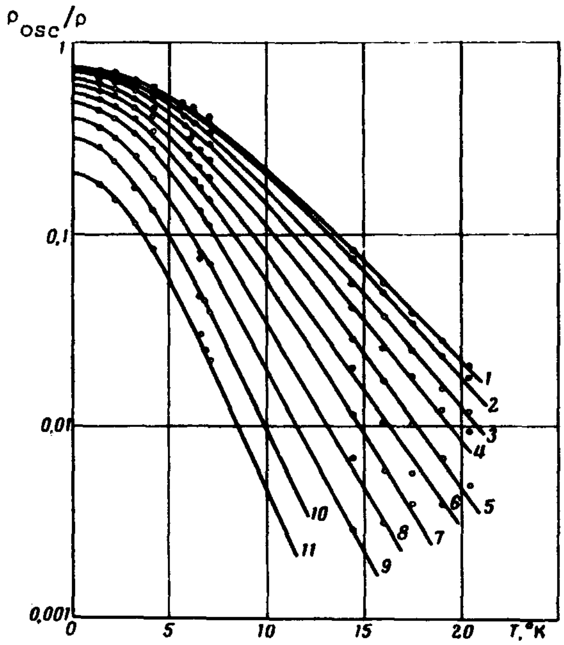

Fig. 1

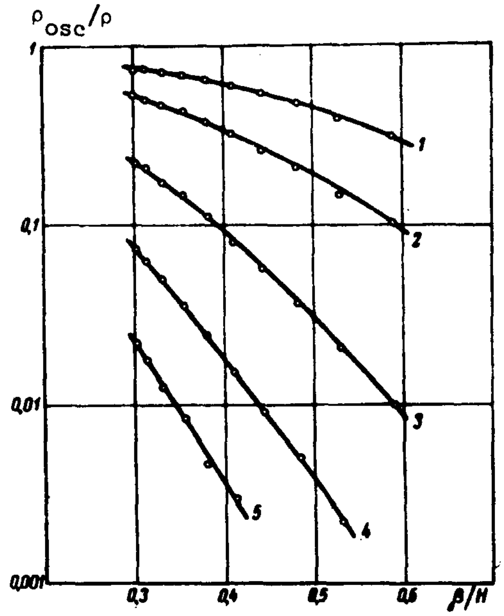

Fig. 2

Fig. 1. Temperature dependence of relative oscillation amplitude at fixed values of the magnetic field: 1 - H = 88 kOe, 2 - 85 kOe, 3 - 80 kOe, 4 - 75 kOe, 5 - 70 kOe, 6 - 65 kOe, 7 - 60 kOe, 8 - 55 kOe, 9 - 50 kOe, 10 - 45 kOe, 11 - 40 kOe.

Fig. 2. Dependence of the relative amplitude of the oscillation on the reciprocal magnetic field at fixed temperatures: 1 - T = 0°K, 2 - 5°K, 3 - 10°K, 4 - 15°K, 5 - 20°K.

used to increase the field (the appratus employed is described in [3]). The sample was placed in a separate cryostat located inside the superconducting solenoid, making it possible to perform measurements at the temperature of liquid helium and hydrogen as well as at intermediate temperatures. In the latter case, the temperature was determined from the resistance of an Allen-Bradley type carbon thermometer, with the permendur concentrators serving as the "thermal block."

Figure 1 shows plots of the relative oscillation amplitude (defined as the ratio of the oscillating part of the magnetoresistance to the monotonic part) against the temperature at different values of the magnetic field. The lines passing through the experimental points are described by the expression

$$\left(\frac{\rho_{osc}}{\rho}\right) = f(H)\,\frac{\beta T/H}{\mathrm{Sh}(\beta T/H)}, \qquad (1)$$

where $\beta = (\pi^2 k/\mu_B)(m^*/m)$.

Such a temperature dependence was obtained in [4] for the de Haas - van Alphen effect. The carrier effective mass determined from the temperature dependence of the oscillation amplitude, was $m^*/m = 0.180 \pm 0.005$, in good agreement with the cyclotron-resonance data [5] for the effective mass of the "cigar."

The dependence of the oscillation amplitude f(h) on the magnetic field, which enters in (1), can be represented approximately, just as for the de Haas - van Alphen effect, in the form

$$f(H) = k_1 e^{-\frac{\beta}{H}D} . \qquad (2)$$

where D is the Dingle parameter and k_1 is a constant. Figure 2 shows a plot of ρ_{osc}/ρ against the reciprocal magnetic field for different fixed temperatures. The Dingle parameters calculated from these plots is shown in Fig. 3.

We see that within the limits of experimental accuracy the dependence of the Dingle parameter on the magnetic field is described by the expression

$$D = k_2 e^{H_0/H} . \qquad (3)$$

Thus, with increasing breakdown probability $p = \exp(-H_0/H)$ the Dingle parameters decrease like $1/p$. The calculated value of the breakdown parameter H_0 turned out to be 110 ± 15 kOe, which is somewhat smaller than H_0 determined from the de Haas - van Alphen effect [6].

In the investigation of the field dependence of the magnetoresistance of beryllium we observed, in distinction from the earlier results [7], a small deviation of the oscillating part of the magnetoresistance from sinusoidal. Figure 4 shows a sample plot of the sample resistance against the magnetic field. We see that the deviation from sinusoidal is manifest by a broadening of the lower part of the oscillatory dependence (the experimentally-observed low-frequency modulation of the oscillations is considered in [8]). If the deviation from a sinusoid is characterized by the width ratio of the lower and upper parts of the oscillations, measured at a distance equal to 0.1 of the

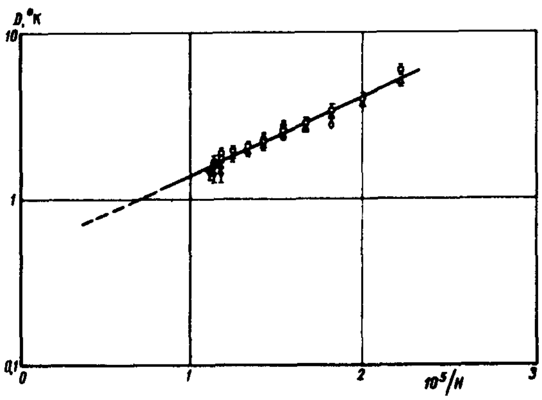

Fig. 3

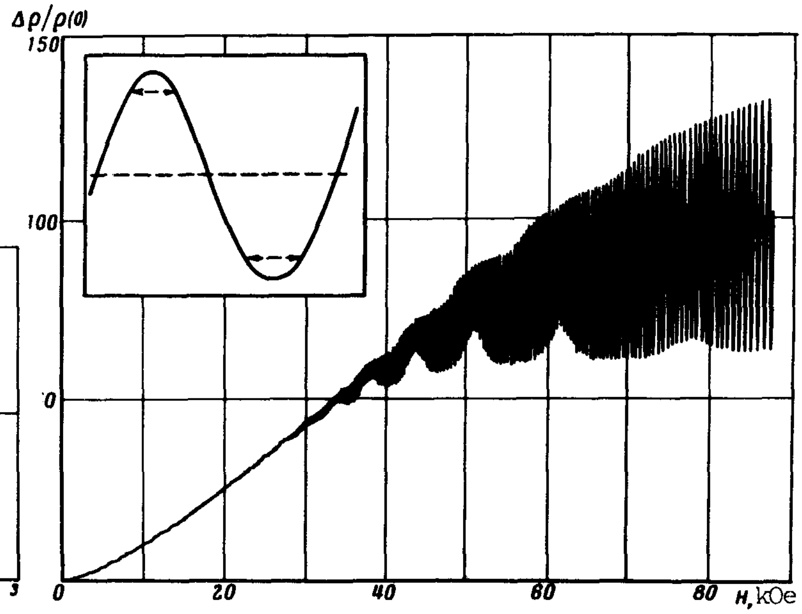

Fig. 4

Fig. 3. Dependence of the Dingle parameter on the reciprocal magnetic field: o - T = 0°K, Δ - 5°K, □ - 10°K, ◇ - 15°K, ∇ - 20°K.

Fig. 4. Sample plot of the magnetoresistance of beryllium against the field at T = 1.4°K. The measuring current is I_{meas} = 100 mA. The dashed line corresponds to the monotonic part of the magnetoresistance. A section of the oscillatory dependence in the region of H ∿ 70 kOe is shown in an enlarged scale.

amplitude to the corresponding extremum of the magnetoresistance (see Fig. 1). Then in our case this ratio is $\delta = 1.25$ at a measuring current $I_{meas} = 100$ mA. With increasing measuring current, the deviation from sinusoidal behavior decreases. Thus, at $I_{meas} = 3$ A we have $\delta = 1.15$. The decrease of the deviation with increasing current is probably due to the increase of the inhomogeneity of the magnetic field over the cross section of the sample, which may cause a smearing of the domain structure of the sample.

The influence of the measuring current on the measurement results is manifest also in the oscillation amplitude. Thus, for example at $I_{meas} = 100$ mA the oscillation amplitude is $\rho_{osc}/\rho = 0.79$ whereas at $I_{meas} = 3$ A we have $\rho_{osc}/\rho = 0.70$, i.e., an increase of the current to 3 A decreases the oscillation amplitude by 12%.

It can be concluded on the basis of these investigations that the carrier effective mass m*/m determined from the temperature dependence of the oscillation amplitude and the breakdown parameter H_0 are in satisfactory agreement with the data obtained by other methods.

The observed dependence of the amplitude and of the form of the oscillations on the measurement current is apparently determined by the change of the inhomogeneity of the magnetic field, and can be reconciled with the results of [7].

The observed dependence of the magnetic-breakdown probability on the field may apparently be the consequence of the coherent effects considered, for example, in [7].

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COSMIC RAYS AND THE ELEMENTARY LENGTH

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Much attention has been paid of late to the disparity between the theoretical estimates and the experimental data on primary cosmic-ray particles with energy $E_p > E_0 \sim 5 \times 10^{19}$ eV. The spectrum of such particles should be cut off at $E_p \sim E_0$, owing to their deceleration by residual photons ($T \sim 3°K$) [1], something not observed in the experiments [2].