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High Field Galvanomagnetic Effects in Bismuth

Spin splitting of the Landau levels due to the holes in bismuth has been observed in pulsed fields up to 175 kilogauss at 1.2°K. The effect was seen in Shubnikov-de Haas oscillations. The oscillatory component of the transverse magnetoresistance R versus the magnetic field H is shown in Fig. 1 with J parallel to the bisectrix axis and H in the binary-trigonal plane. θ is the angle between H and the binary axis. The arrows show how rapidly the spin splitting of the levels increases as the field is tipped away from the binary axis. The oscillatory magnetoresistance when **H** is almost parallel to the trigonal axis is shown in Fig. 2. The splitting factor Δ (equal to the ratio of spin splitting to the Landau level separation) is nearly integral in this case. The double peak near 100 kilogauss is thought to be due to the superposition of an unsplit hole level and one of the last electron levels. This conclusion is supported by the temperature variation of the oscillations. The observation of the unsplit hole level suggests that the splitting factor is near two.

The g-factor for the holes was obtained from the expression

$$g = 2\Delta\ (m/m^*).$$

The values for the cyclotron mass m^* were taken from the work of Khaikin[1] *et al.* The g-factor has the form

$$g = (\lambda_1^2 g_1^2 + \lambda_2^2 g_2^2 + \lambda_3^2 g_3^2)^{1/2},$$

where λ_1, λ_2, λ_3 are the direction cosines of **H** relative to the binary, bisectrix, and trigonal axes. A plot of g in the binary-trigonal plane as shown in Fig. 3 shows the expected linear variation. Extrapolation to the trigonal axis gives a g-factor for this direction of 64 ± 3. The splitting along the binary axis could not be resolved and the corresponding g-factor is thus less than unity.

Reference

1. M. S. Khaikin, R. T. Mina and V. S. Edel'man, *Soviet Physics—JETP* **16**, 1459 (1963).

Figure 1

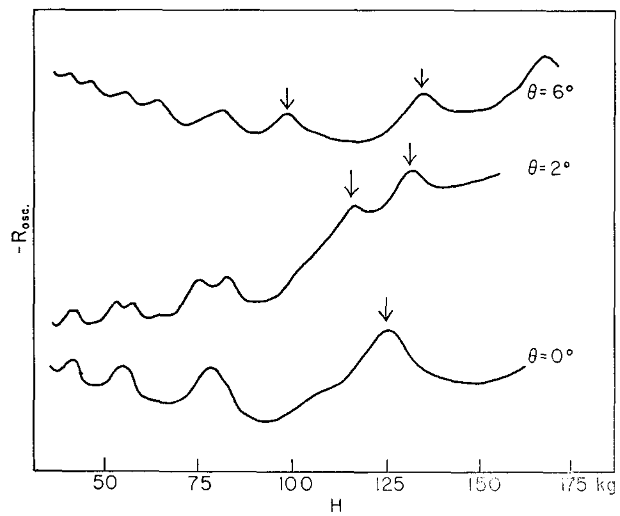


Figure 2

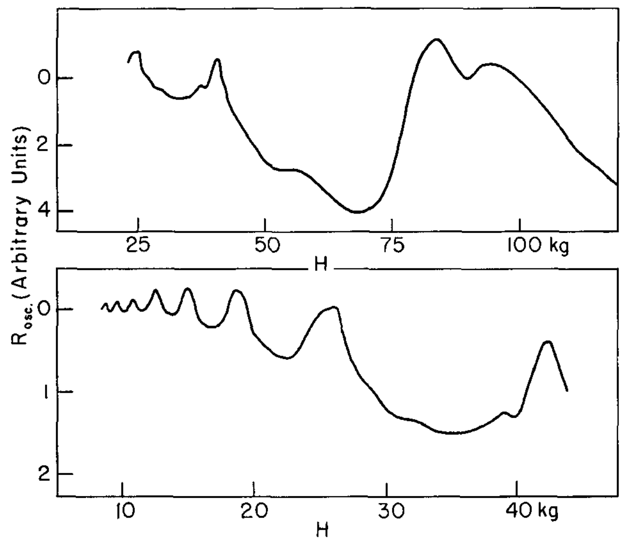
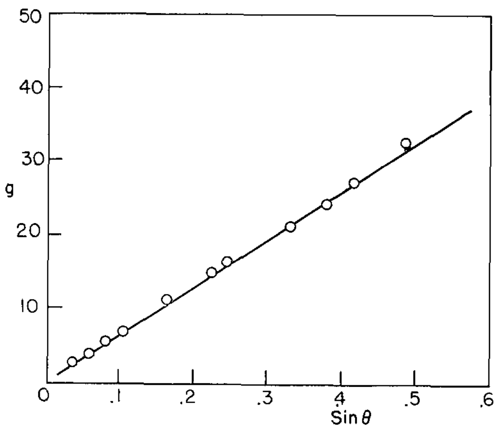


Figure 3



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