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Infrared Reflectivity of Bismuth in the Quantum Limit†

The infrared reflectivity of Bi in a magnetic field has been investigated between 100 cm^{-1} and 400 cm^{-1} in the quantum limit (cyclotron energy comparable to Fermi energy). A sharp decrease in the reflectivity[1] occurs at that field at which transitions first become possible between the lowest two Landau levels of the conduction band. Calculations[1,2] of the position of the absorption edge using two-band models[3,4] agree well with observations and make possible an accurate determination of the Fermi energy as well as cyclotron splittings away from $k_z = 0$. In addition quantum effects strongly influence the position of the reflection minimum near the field-modified plasma frequency. The position of the minimum has been studied for electric fields polarized both perpendicular and parallel to the magnetic field, and comparison will be made with calculations based on two-band models.

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† A summary.

References

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3. B. Lax, J. G. Mavroides, H. J. Zeiger and R. J. Keyes, *Phys. Rev. Letters* 5, 241 (1960); R. N. Brown, J. G. Mavroides and B. Lax, *Phys. Rev.* 129, 2055 (1963).
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Discussion

M. S. Dresselhaus: Have you seen, or would you expect to see, structure in your data due to the fact that the effective g-factor is not precisely $2m_0/m^*$?

L. C. Hebel: We see no pronounced effect which can be attributed to spin splitting. This has worried us. However, the reflectivity is determined by both $\mathrm{Re}(\epsilon)$ and $\mathrm{Im}(\epsilon)$. An extra contribution to $\mathrm{Im}(\epsilon)$, due to a spin-split level going through the Fermi energy at about 15 kG, could make the reflectivity increase, decrease or stay the same, depending upon the size of $\mathrm{Re}(\epsilon)$. Thus, the fact that we see no pronounced change in reflectivity at 15 kG is not evidence against spin splitting.