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Anomalous diamagnetism

In a letter in *Nature* of June 22 (p. 945), reference was made to the Ehrenfest hypothesis which ascribes the high diamagnetic susceptibility of bismuth to the existence of closed electron orbits of larger than atomic dimensions in association with the crystal lattice.

It may be pointed out that the existence of such orbits appears to furnish a very natural explanation of a variety of phenomena which up to now have been obscure. In the first place, the extremely pronounced diamagnetic anisotropy characteristic of bismuth (and also of graphite) becomes immediately intelligible as a consequence of the specific orientation of the assumed electronic circulations within the crystal lattice. Further, the large Hall effects and changes of electrical resistance exhibited by bismuth and graphite when placed in a magnetic field become comprehensible, since the electronic circulations would be modified by the field, and result in corresponding modifications of the flow of electricity through the substance under a simultaneously impressed electromotive force. There would be every reason to expect, as is indeed the case, that the magnitudes of the Hall effect and the change of resistance would depend on the orientation of the crystal in the magnetic field and the direction of flow of electricity through it.

Then again, with rise of temperature and consequent thermal derangements of the lattice, the postulated electronic circulations would tend to disappear and give place to chaotic electronic movements. The diamagnetic susceptibility would then diminish towards its normal value for a non-crystalline condition of the substance, and corresponding changes would occur in the coefficients of the Hall effect and magnetic variation of electrical resistance. That liquid metals do not, so far as I am aware, exhibit a measurable Hall effect is significant in this connexion.

In close analogy with the influence of temperature, and presumably to be explained on very similar lines, is the remarkable fact that the anomalous diamagnetism of bismuth and of graphite tends to diminish or disappear when the substances are reduced to a colloidal condition.

Finally, it may be remarked that the dimensions of the crystal lattice, cannot be uninfluenced by the existence of such regular electronic circulations within it or by modifications produced in them by an external agency. That the magnetostriction of bismuth in strong fields discovered by Dr Kapitza (*Nature*, July 13, p. 53) is connected with the anomalous diamagnetism of the substance admits of little doubt. The notable increase in magnetostriction at low temperatures observed by him appears to fit in very well with the Ehrenfest hypothesis.

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