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Diamagnetism and crystal structure

Prof. Ehrenfest has suggested (*Physica* 1925 **5**, p. 388) that the high diamagnetic susceptibility of bismuth is to be ascribed to the existence in the metallic crystal lattice of electron orbits of large area including several atoms within their radius. There seems good reason to extend Ehrenfest's hypothesis to the case of carbon as well, since it affords an illuminating insight into the magnetic behaviour of the different forms of this element. It is known that graphite possesses a high specific susceptibility, which according to the most recent measurements of Vaidyanathan with carefully purified samples, is $-5{\cdot}1 \times 10^{-6}$, that is, quite ten times larger than the specific susceptibility of diamond ($-0{\cdot}49 \times 10^{-6}$), the latter being practically the same as that of carbon in organic compounds as found from Pascal's additive law. The abnormal susceptibility of graphite becomes intelligible in terms of the peculiar structure of the substance and its electrical conductivity, if we assume that there are electron orbits circulating round the plane hexagonal rings of carbon in the crystal-lattice. This fits in with the known fact (observed by Honda and Owen) that the susceptibility of graphite is six or seven times greater normal to the planes of cleavage than parallel to them. Diamond, on the other hand, being a dielectric would naturally not show the abnormal susceptibility.

Careful studies made by Mr P Krishnamurti of the X-ray pattern of sugar charcoal and lamp-black prove conclusively that these substances do not possess any crystalline structure. The fact that amorphous carbon has the normal susceptibility ($0{\cdot}51 \times 10^{-6}$), and not the high value of graphite, is therefore quite to be expected. The great diminution in the susceptibility of bismuth which occurs on fusion may be regarded as an analogous phenomenon.

Ehrenfest's hypothesis would appear to have also other fruitful applications, for e.g. in the explanation of the remarkable diminution in the susceptibility of graphite at high temperatures and of the dependence of susceptibility on particle size in colloidal substances. We need not, however, enter into those details here.

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