LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

The Magnetization of Colloidal Suspensions

If one assumes the Weiss-Heisenberg postulate of spontaneously magnetized "domains," then it is difficult to see how it is possible to demagnetize a ferromagnetic body. The recent work of Akulov,[1] Powell,[2] and Bitter[3] has done much to resolve this difficulty, but it would still be desirable to obtain more direct experimental evidence of the existence of these domains, as all investigators in this field are not yet fully convinced of their reality. An estimate of the size of these domains can be made from the rate of the approach to saturation of the material in high fields. Such a calculation has recently been made by Bitter,[3] with the result that a group containing approximately 10^5 atoms would constitute a domain. This corresponds to a linear dimension of the order of 150 mμ. Hence if we could divide a ferromagnetic body into particles this small, we should expect each particle to be magnetically saturated.

Colloidal suspensions of nickel or iron can be obtained with this order of particle size, and an investigation of their magnetic properties should be interesting. In suspensions of this character, the concentration of the particles would be so small that the effect of one particle on another could be neglected. The suspension would thus be equivalent to a gas composed of large molecules, and its magnetic moment would be given by the Langevin formula

$$N\bar{\mu} = N\mu\left(\coth\frac{\mu H}{kT} - \frac{kT}{\mu H}\right)$$

where N is the number of particles per cc, and μ the magnetic moment of each particle. For a particle of nickel of diameter 150 mμ, we have a saturated magnetic moment of 7.0×10^{-12} c.g.s. m per particle, and if we take a field of 1000 gauss and $T=300°$K, then $\mu H/KT$ has the value 1.7×10^5. Under these conditions, the suspension as a whole will have a magnetization within 10^{-3} percent of that possible at this temperature. If, however, we decrease the magnetic moment of the particle by reducing its size, the Brownian rotations of the colloidal particles will become important, since the magnetic moment will assume directions determinate with respect to the directions of the crystal axes, and $\bar{\mu}$ will become smaller than μ. We might thus trace out a Langevin curve. The same result can, of course, be accomplished by varying either the field of the temperature, but the feasible range of variation of H or T, especially of the latter, is much less than that of μ.

Such evidence would, of course, constitute a very direct proof of spontaneous magnetization of small particles. A suspension of particles of this character would also show other interesting properties. It should exhibit a magnetic viscosity which would be directly dependent on the viscosity of the medium in which the particles are suspended, and there should be no hysteresis of the ordinary kind.

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[1] Akulov, Zeits. f. Physik **69**, 78–99 (1931) and earlier papers.

[2] Powell, Proc. Roy. Soc. **A130**, 167–181 (1930).

[3] Bitter, Phys. Rev. (2) **38**, 528–548 (1931).