polymers (rubbers), and the statistical approach to the study of cross-linking and copolymerization—a fascinating field in which the correspondence between theory and experiment is refreshingly close—and associated problems.

In the remaining chapters the emphasis is on the observed properties of materials. Subjects dealt with are crystallization and its effect on mechanical properties of rubbers and fibres, the mechanical behaviour of wool and rayon, solution properties and plasticization of polymers. The final chapter deals with the question of tensile strength, both from the theoretical and experimental points of view.

Regarding the book as a whole, the treatment generally is sufficiently detailed and extensive for the reader to obtain a very fair grasp of the more important contributions to the subject, even without consulting the original literature. In many places sections of the original papers are quoted *in extenso*, which is extremely helpful for the reader who is actively engaged on research in a particular subject. On the other hand, this method has the drawback of breaking up the smooth development of the subject, making the presentation appear somewhat disjointed, with different parts of the same subject cropping up in various places. It is unfortunate that the section on optical properties could not have included a reference to the work of Kuhn and Grün (1942) on the statistical theory of the photo-elasticity of strained rubber.

The author is at his best in dealing with the general mathematical theory of visco-elastic phenomena, a subject to which he has made important contributions, some of which are set out in mathematical appendixes. The reviewer knows of no other book in which this subject is discussed in anything like the same detail, nor in such a masterly and lucid manner. Mathematics, however, is not physics, and the number of examples in which this kind of formal analysis has been successfully applied to real materials is still quite small. Moreover, there is the very serious difficulty (explicitly stated on p. 218) that the theory discussed is not applicable when the deformations encountered are large. Just as, in rubber elasticity, it has been found necessary to get right away from the classical (small-strain) theory and develop a theory in which large strains are included right at the start, so it may be necessary ultimately to develop a genuinely large-strain visco-elastic theory for the analysis of the non-equilibrium phenomena encountered in rubbers and plastics.

This is not a book for beginners; but for those who already have some knowledge and experience in high-polymer physics, it will be highly valued not only as an everyday guide but also, and perhaps primarily, as a source of inspiration for further research.

L. R. G. TRELOAR

MECHANISM OF MAGNETIZATION

Paramagnetic Relaxation

By Prof. C. J. Gorter. Pp. vii+127. (New York and Amsterdam: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1947.) 12*s*. net.

ALTHOUGH Langevin's theory of paramagnetism is known to every physics student, the study of the mechanism of the magnetization process is comparatively new; Waller's first calculations were published in 1932, and experimental investigations may be said to begin with Prof. C. J. Gorter's first paper in 1936. Since then it has been intensively studied under his leadership in several of the Dutch universities; but, up to the present, many of the results have been published only in the form of theses. This monograph, written in Holland during the 'starvation winter' of 1944–45, is the first book to be devoted to the subject.

The magnetization of a paramagnetic salt is an equilibrium between the forces exerted on the magnetic ions by the magnetic field, the random forces of thermal agitation, and the constraints due to interactions either among the magnetic ions themselves or between the ions and the surrounding crystal lattice. When this equilibrium is disturbed by a change of magnetic field, it can be re-established only by a flow of heat, which proceeds at a rate which can be described in terms of two characteristic relaxation-times. As the time for the establishment of thermal equilibrium among the magnetic ions, or spin relaxation-time, is generally appreciably shorter than that for equilibrium between the ions and the crystal lattice, and also has a different dependence on magnetic field, it is possible to separate the two effects experimentally.

After a brief review of the theory of paramagnetism, Prof. Gorter surveys the experimental methods used in relaxation work. Essentially, these are measurements of magnetic dispersion or absorption at different frequencies; but, as the relaxation times range from spin relaxation-times of 10^{-10} sec. to lattice relaxation-times which at low temperatures may exceed 0·1 sec., a great variety of techniques has been employed. The high-frequency circuit work is nowhere very elaborate—it must be remembered that the whole of the work described is based on 'pre-radar' radio technique—but some of the methods used are beautifully simple, notably the work of H. Volger. There follows a summary of the experimental results, and a discussion of their significance in the light of the theory of lattice and spin relaxation.

For many readers the greatest interest will lie in the values which emerge for the magnetic specific heats. When the spin relaxation-time is sufficiently short compared with the lattice relaxation-time, measurements at a suitable frequency give the magnetic susceptibility under adiabatic conditions, in which the magnetic dipoles, although in thermal equilibrium among themselves, are effectively isolated from the surrounding crystal lattice. From this measurement, combined with that of the ordinary isothermal susceptibility, the specific heat of the dipole system can be obtained by a simple thermodynamic transformation. In the few cases in which the comparison is possible, this elegant method gives specific heats which yield values for the magnetic energy-levels in good agreement with those obtained by other methods. The experimental results on relaxation-times, on the other hand, have not yet been fitted into a satisfactory theoretical framework. The dependence of the lattice relaxation-times on magnetic field is not consistent from one substance to another, while the experimental data do not yet suffice for a full analysis of its temperature dependence.

While its appeal is necessarily specialized, Prof. Gorter's book is an important contribution to the study of paramagnetism. It is beautifully produced and printed—an important point in a monograph containing so many numerical data. It has no index.

A. H. COOKE