THE PHYSICS OF THE SOLID STATE

Solid State Physics

Advances in Research and Applications. Edited by Frederick Seitz and David Turnbull. Vol. 2. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 10 dollars.

THE second volume of "Solid State Physics" maintains the high standards set by the first. Moreover it contains matter which will be of interest to physicists and chemists who, although perhaps unable to distinguish an exciton from a donor level, wish to know something of the applications of nuclear magnetic resonance and neutron diffraction to structural and dynamical problems.

Six years ago G. E. Pake contributed a pair of excellent expository articles on nuclear magnetic resonance to the *American Journal of Physics*. They are now expanded and brought up to date in the first article of the present volume. The author gives very clear explanations of such vital concepts as line breadth and its associated 'spin-spin' relaxation time as well as the dynamically determined 'spin-lattice' relaxation time. Yet perhaps one can, without being churlish, deplore the lack of a unified approach which recent theoretical work would seem to make possible. The newer techniques and discoveries are exciting and are well explained. For example, the treatment given here of Hahn's 'spin echo' methods is much more easily understood than the original papers; this technique is clearly important for investigating diffusion processes as well as relaxation times. An interesting new development is that partial polarization of nuclei can be induced by saturating the electron spin resonance of certain metals. Just as the polarization of electrons produces in any event a slight shift in the nuclear resonance frequency (discovered by Knight), so in turn does the nuclear polarization react on the electronic resonance and shift its frequency. Pake suggests that the latter shift should be called the 'day shift', since it dawns as the Knight shift subsides.

W. D. Knight discusses his shift in considerable detail in the second article, on nuclear magnetic resonance in metals. The interest here is more specialized. The effect is proportional to the Pauli susceptibility and the electron-nuclear (or hyperfine) interaction in the metal. It is therefore closely linked to the problem of electronic structure and is fairly complex. Considerable progress seems to have been made already, and in due course the phenomenon should be a useful source of information to the metal physicist.

C. G. Shull and E. O. Wollan present a superb account of the structural information so far obtained from experiments on neutron diffraction. The power of the technique can be seen by contrasting the remarkably detailed information it yields about the ammonium halide transitions (p. 155) with the very partial results obtained from nuclear resonance studies (Pake's article, p. 81). Other important structures which have been investigated by neutron diffraction include: ice (Pauling was right), some ferro-electrics and liquid helium. Scattering of neutrons by phonons gives what is at present rather crude information about the vibrational spectrum. Results from magnetic scattering by unpaired electrons are numerous and precise; the technique is obviously of special importance to students of magnetism.

The theory of specific heats and lattice vibrations is dealt with in a leisurely and lucid way by J. de Launay. A good deal of this material is well known, but there are some fresh results, including some particularly careful comparisons of theory and experiment.

The longest article in the book (140 pp.) is by F. Seitz and J. S. Koehler on the displacement of atoms during irradiation. The authors can scarcely be blamed if outsiders find that this is the least satisfactory article in the book: the subject is intrinsically of great complexity. It may well be that to those working in the field of irradiation displacements the article will serve as a searchlight, because it concentrates on quantitative arguments even when they turn out to be wrong by a factor of 5 or 10. However, this sort of thing is very demoralizing for non-specialists, and one wonders whether it might not have been better to have published the article elsewhere.

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DESIGN FOR STATISTICIANS

Experimental Design

Theory and Application. By Prof. Walter T. Federer. Pp. xix+544+47. (New York and London: The Macmillan Company, 1955.) 77*s*.

AN author who plans to teach the practice of design and analysis of experiments commits himself to writing more systematically and in greater detail than Fisher, yet at a lower level of mathematical sophistication than Kempthorne. However useful his book for reference purposes, he can scarcely expect it to prove attractive for consecutive reading. Despite these difficulties, Prof. W. T. Federer has produced a book that will be valuable to statisticians and experimenters.

Comparison with Cochran and Cox, whose similarly titled book has established a high standard, is inevitable. Federer includes a greater range of designs, especially in respect of factorial sets of treatments and of types of lattice, and his instructions for analysis of these will be widely used. He is less successful in showing relations between designs, his system of classification tending to emphasize distinctions rather than connexions. Disappointingly, but perhaps not surprisingly in view of the difficulty of the problems, the discussion of change-over and rotation experiments is quite inadequate. The Box–Wilson methods of exploring response surfaces receive only a reference that gives no clue to their nature. The lengthy account of alternative significance tests in Chapter 2 is not particularly relevant to design, and, in view of the incomplete discussion of some interesting categories of design, its inclusion seems an error of emphasis.

Many readers will regret the frequency with which ideas and techniques are left undescribed, with no more than a reference to the original publication in a journal. The impressive list of 340 references is of interest for many unfamiliar items, and remarkable for some of the omissions. In so long a book, however, one might expect to find the argument of important papers digested and summarized; too often, all that appears is a statement of conclusions, or perhaps only the title of an unpublished paper or inaccessible report, and a proper appreciation of even Prof. Federer's own work is impeded in this way.