Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (M.M. Woolfson, Physics Department, University of York, Heslington. York, England). As far as practicable books will be reviewed in a country different from that of publication.

Proceedings of the Symposium on Low Energy Electron Diffraction, Ramada Inn, Tucson, Arizona, February 1968. *Transactions of the American Crystallographic Association,* Vol. 4. 1968. Pp. v+114. Price $ 5.00 postpaid from Polycrystal Book Service, P.O. Box 11567, Pittsburgh, Penn. 15238, U.S.A.

Low energy electron diffraction (LEED) has been the subject of a rapid growth of interest over the last three years because of its usefulness in the study of interfacial chemistry, semiconductor surfaces and epitaxic growth. These *Proceedings* are a useful set of papers and discussions which highlight the important issues of the moment in this field. They include a particularly valuable review of the methods of interpretation of LEED patterns written by Professor R. M. Stern, who presents evidence that a three-dimensional, two beam dynamical theory of electron scattering can be expected to be a good description of the elastic processes occurring. Other important papers are by Morgan & Somorjai and by Palmberg who present evidence for structural rearrangements at the clean surfaces of platinum and gold respectively. Such structural rearrangements were previously thought to occur only in the covalent bonded materials such as silicon and germanium.

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Theory of elastic waves in crystals. By FEDOR J. FEDOROV. Translated from the Russian by J.E.S. BRADLEY. Pp. 375 + 19 Figs. New York: Plenum Press, 1968. Price $ 25.

The modern developments involving ultrasonic generators and detectors, piezoelectric resonators and phonon interaction with X-rays and other types of radiation all require an understanding of the transmission of elastic waves through solid bodies and especially through crystals. Many standard works on the physical properties of crystals have one or more chapters devoted to the study of the propagation of plane elastic waves through crystals of various symmetries. However, the book under review is remarkable in that it is entirely devoted to this subject. It is based on a series of lectures given to graduate students in Moscow University but it would be misleading to imply that it is a book which students will find easy to read. It has the character of a monograph rather than that of a student text. In a foreword, H. B. Huntington says 'the author has gone to considerable pains to develop in his mathematical background a consistent tensor framework which acts as a unifying motif throughout the various aspects of the subject'. The author also explains in the Preface to the Russian edition that his method is based on general methods of vector and tensor calculus which do not necessitate explicit statement of the tensor components. This generalized tensor analysis makes the reading unfamiliar and, until the language is learned, rather difficult, but it gives a unity to the whole presentation.

There are nine chapters, the first three of which cover the relatively familiar ground leading to Christoffel's equation and its applications. Chapter 4 gives an account of the flow of energy and the form of wave surfaces. In the next three chapters the theory is applied, first to an isotropic medium, and then to hexagonal, cubic, tetragonal and trigonal crystals. Chapter 8 is concerned with the reflexion and refraction of elastic waves from plane boundaries and covers ground not usually to be found in the standard works. The last chapter deals with the calculation of Debye temperatures taking into account the elastic properties of cubic and hexagonal crystals.

The translation appears to be excellent and the production is good except that the suffixes are often rather too small to be seen easily.

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Anharmonic crystals. By R.A. COWLEY. Pp. 44. *Reports on Progress in Physics*, Vol. XXXI. Part 1, p. 123, 1968. Price (single article, paper cover) £1.1*s* or 14*s* 0*d* to members of the I.P.P.S.

Much progress has been made in recent years in the theory of anharmonicity in crystals. The methods developed involve advanced techniques such as the use of thermodynamic Green's Functions, the algebra is complicated, and the relation between the results obtained and experimental observation is often far from clear. Dr Cowley's review of the present state of the art is therefore especially welcome.

The theories of thermal expansion, elastic and dielectric properties, Raman and neutron scattering, and specific heat are discussed in terms of an expansion of the interatomic potential in which only the lowest order terms are retained. The role of anharmonicity in the non-equilibrium thermodynamic properties such as thermal conductivity and second sound is certainly less well understood. Where anharmonic effects are large, the usual perturbation scheme breaks down, and new approaches, not based on expansions of harmonic basis states, have been developed; Dr Cowley

makes illuminating comments on the relation between such methods and the results of the conventional perturbation procedure.

Few details are given of the manipulative techniques involved, but a clear statement is presented of what has gone in to each calculation (the terms in the perturbation expansion that have been considered, the interatomic potential *etc*). The sense in which results obtained can be compared with experiment is then simply described.

In places the terseness of the presentation will defeat the non-expert, but when one considers the difficulty of the task, Dr Cowley has done excellently.

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Low energy neutron physics. BY I. I. GUREVICH AND L. V. TARASOV. Translated by SCRIPTA TECHNICA LTD. (LONDON) and edited by R. I. SHARP AND S. CHOMET. Pp. xiv + 607. Amsterdam: North-Holland Publishing Co. 1968. Price *f.* 90.

This book is of much more interest to crystallographers than its title suggests, for it is very largely concerned with the use of thermal neutron beams for studies of the structures of solids and liquids. This concentration on the solid-state aspects of slow neutron physics is made clear in the authors' preface and they define their purpose even more closely as concentrating on nuclear scattering rather than magnetic scattering. Indeed they see their book as complementing that of R. P. Ozerov & Yu. A. Izyumov on *Magnetic neutron diffraction* which has not yet appeared in its English translation.

There is indeed one chapter which deals with such topics as neutron-proton and neutron-electron interactions, the magnetic moment and any possible electric dipole moment of the neutron, but by far the greater part of the book is of primary interest to the student of solids. The book will be of great value to those who are doing research in this field. Nevertheless it is particularly recommended for the notably successful accounts which it gives of the physics which underlie the topics which it describes, especially perhaps some of the techniques of inelastic scattering. The book is divided into five parts called respectively Fundamentals of Low Energy Neutron Physics and Atomic Dynamics of Matter, Slow Neutrons in Nuclear Studies, Studies of the Condensed State, Scattering by Chemically Bound Nuclei and Scattering by Magnetic Crystals and each part contains several chapters. This arrangement ensures very full coverage but at the expense of fragmenting some of the descriptions, which makes it difficult for the reader to find his way about the book. There is an index of nine pages but having tested it out on a number of topics the reviewer has concluded that its choice of entries is not very successful. For example, the word 'approximation' has eleven sub-entries, there is a whole page of entries under 'neutron' and a further page under 'scattering' but the words absorption, fission and inelastic, to mention a few, do not appear.

In spite of these drawbacks the book is a very valuable contribution to the literature on this subject. It is well-written and translated and commendably readable; at the same time the research worker will find it a good work of reference.

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Electron Paramagnetic Resonance. BY J. W. ORTON. Pp. 240. London: Iliffe, 1968. Price 65*s*.

Dr Orton's book concentrates on the microwave spectroscopy of transition group ions in dielectric crystals. Thus it complements, rather than competes with, more general texts, such as those by Ingram & Pake, although the introductory chapters on the basic concepts of paramagnetic resonance spectroscopy enable the uninitiated reader to find his bearings. After a preparatory review of appropriate quantum mechanical operations, the reader is introduced to the concept of the spin Hamiltonian as a convenient and powerful way of expressing the energy of a paramagnetic ion in a crystal. Subsequent chapters deal with transition probabilities and crystal field theory. The author approaches these subjects from the experimentalist's point of view drawing repeatedly on particular examples to develop his arguments. Whilst this presentation lacks the elegance and rigour of a more abstract approach it does enable the reader to appreciate the physical and practical content of the theory. The discussion on crystal field theory is approached from the point change model, with its simple pictorial representation, and from crystal field operators. No use is made of group theory, though the importance of symmetry is clearly indicated and refinements to the point change model are discussed. The section on magnetic properties of ground states will be of particular value to experimentalists wishing to enter this field, since it painstakingly shows how such properties can be expressed in terms of standard coupling coefficients and crystal parameters which are convenient starting points for more detailed theoretical analysis. The final sections of the book are concerned with short discussions of spin-lattice relation, experimental techniques and of results (up to 1966) for the transition group elements. However, no mention is made of combined optical and microwave spectroscopy such as the work of Geschwind *et al.* on the e.p.r. spectra of optically excited states of Cr in ruby, *etc*.

In summary, this book is a valuable introductory or refresher manual on the interpretation of microwave spectra of paramagnetic ions in crystals. Not only does it provide the necessary theoretical background for a general understanding of the subject, but it also shows the experimentalist how to 'process' his results into standardized and theoretically useful forms.

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