understanding of high resolution n.m.r. spectra and the application of symmetry methods is the subject of the second article in this volume. An elementary description of symmetry elements and operations is given, followed by discussions of the symmetry of non-rigid systems, permutation groups, factorization of the Hamiltonian matrix, the X approximation, and a brief section on sub-spectral analysis. Appendices include a discussion of matrices and vectors, a 'worked example' for the $A_2A_2'XX'X''X''$ system, and character tables. Unfortunately this chapter does not meet the stated aims of the editors. The subject matter is not developed with particular clarity, and is further confused by an inconsistent and clumsy numbering of sections, subsections, and equations, *etc.* (especially pages 118, 119 and 122). The definitions of magnetic equivalence and inequivalence are confusing and incompletely referenced. Although standard textbooks on n.m.r. and on symmetry are listed in the bibliography it is surprising to find no reference to the book by Corio. Group character tables are available in many texts, their reproduction here would be worthwhile had they been specifically adapted to n.m.r. There are errors in the C_{5h} and C_{6h} tables. Speaking of errors, a hypothetically oriented methane molecule is expected to have a five line spectrum (page 120).

If greater attention is paid to the editorial philosophy this series should be a worthwhile and valuable one. The first volume is highly recommended to anyone working in these specific areas of n.m.r. but the unitiated might have a difficult time bridging the gap between introduction and latest development.

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Crystals. By PETR KRATOCHVIL. Pp. Ill. London: Iliffe, 1967. Price (paperback) 15 *s.*

'Physics paperbacks' are a series of monographs which claim to provide an 'inexpensive, succinct, rapidly absorbed yet comprehensive introduction to a number of advanced physics subjects for science and technological students.... Each monograph has been written by a distinguished Czech physicist, and edited, and where necessary updated, by an English specialist'. The author's introduction notes the vast progress made in electrical engineering during recent years and makes it clear that the book is aimed mainly at readers interested in this field and more particularly in the development properties and technical applications of metals and semi-conductors.

The book consists of four chapters:

(1) The structure of matter
(2) Crystal structure
(3) Origin of crystals
(4) Properties of crystals and their applications.

Chapter 3 is only slightly less in length than the other three put together and this tends to throw the book out of balance because of too great detail on specialist topics such as zone melting and methods of growing crystals, while other more interesting topics are declared to be beyond the scope of this book. Three instances of this irritating feature (particularly when no guidance is given for further reading – in fact there is no bibliography, as such, anywhere in the book) were noted: (*a*) interactions between defects (p. 31) (*b*) influence of grain boundaries on physical properties of materials (p. 44) (*c*) the dependence of the electron structure of metals on valency (p. 101). However, any book in this interdisciplinary field is welcome and it does avoid the Scylla of too much theoretical crystallography and, apart from the exceptions noted above, the Charybdis of too much practical detail.

If the book lacks anything it is on the geometrical side, using the word geometry in its most general sense. The usual geometrical topics, which are essential in any book on crystals, are discussed; *e.g.* space lattice, dislocations and close packing. On the other hand polymorphism is not mentioned, nor are liquid crystals nor the many aspects of morphology, which, though particularly applicable to crystalline polymers, are also of interest in a much wider field, *e.g.* spherulites, lamellae, fibres and microfibrils. Reference is however, made to dendrites and whiskers. This is understandable in a book mainly concerned with metals and semi-conductors. The title *Crystals* perhaps raises too many hopes.

The production is good and the index is quite adequate. There are printing errors but on the whole these are not troublesome. A few mistakes were detected; there may be others. Some of these arise from translation and can be readily corrected by the reader, *e.g.* 'tetrahedron' is obviously meant where 'quadrilateral' is used (on p. 20) referring to the four bonds of the carbon atom. On p. 29, in Fig. 10, the labelling of the axes does not correspond with the text. A mistake due to inadequate updating was noted on p. 16 where noble gases are 'totally inert in chemical reactions'. What about the recently discovered chemistry of xenon? An example of a more substantial mistake occurs on p. 9 where 'every element then has its own particular atomic number and this determines its physical properties'. Here was a chance to mention the allotropy of the elements (one aspect of polymorphism) and avoid this error. For example the two forms of tin have the same atomic number but widely differing densities.

This book can certainly be recommended for students but is too light weight for those who would wish to delve more deeply.

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X-ray diffraction methods in polymer science. By LEROY E. ALEXANDER. Pp. 582 + xv. New York: Wiley – Interscience, 1969.

This monograph is a most valuable compilation of material which, up to now, has been scattered through a wide range of journals such as *J. Polymer Sci., Kolloid-Z., Phil. Mag., Helv. Chim. Acta, Makromol. Chem., Nuovo Cimento, Acta Cryst., Nippon Kagaku Zasshi, etc., etc.* Among other purely factual items are almost five hundred references to specific papers in the text and a further five hundred refer-

ences to papers from which the thirty-six pages of crystallographic data for about 270 polymers have been derived. Numerous general references are also included.

The introductory chapter discusses first the basic concepts associated with crystallization in polymers and with X-ray scattering in general; then follow more detailed discussions of both wide-angle and small-angle scattering by polymers. Chapter 2 deals with instrumentation and includes treatment of the problems of specimen preparation and mounting, comparative discussions of diffractometer and photographic methods, and a section on optical diffractometer techniques for interpretation. Chapters 3 and 4 discuss the fascinating and controversal subject of degree of crystallinity in polymers and preferred orientation respectively. The remaining chapters deal with the possibilities of obtaining information on macro-structure from low-angle scattering, relationships between micro-structure and wide-angle scattering and finally a shorter treatment of the problems of lattice distortion and of crystallite size. The book is written for research workers in two main categories – those engaged in polymer studies who want to understand the contribution that X-ray diffraction can make and those engaged in X-ray diffraction studies who wish to widen their experience of their application in materials science.

It is difficult to know where to begin in commenting on such a large and comprehensive book but, as an X-ray crystallographer relatively recently entering the field of polymers, I found the chapter on the degree of crystallinity and the two on macro- and micro-structures perhaps the most valuable. The presentation is highly concentrated but extremely clear and will save newcomers to the field enormous amounts of time in hunting through the literature. The author manages to mix purely technical and experimental details with discussions of the background theory and even detailed step-by-step instructions for carrying out analyses of resulting data.

This book would earn its place on the library shelf purely for the factual material which has already been mentioned at the beginning of this review, but its place in the laboratory and on the desk is also fully justified by the clarity and completeness of the exposition and the sense of prospective balance that it brings to its subject.

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Elements of X-ray crystallography. By LEONID V. AZAROFF. Pp. xvi+610. New York: McGraw-Hill, 1968. Price £7.7 *s.*

Elements of X-ray Crystallography is an attempt to provide a complete introduction to all the important topics which constitute the subject of X-ray crystallography. Any author who attempts such a difficult and complicated task is to be admired. The author of this book, L. V. Azaroff, deserves special praise for he has produced an excellent book which to a very large extent fulfils the above aim.

The book is divided into four main parts. Part I, *Elements of Crystals,* consists of four chapters and gives a clear account of symmetry elements, crystal morphology, crystal projections, lattices and space groups. It is an impossible task to deal comprehensively with space group theory in a few pages but the author has given sufficient information to introduce a reader to the subject. Part II, *Elements of X-ray Physics,* contains two chapters. The first chapter, a historical note, briefly summarizes the development of X-ray crystallography since the initial discovery of X-rays by W. C. Röntgen and the contribution to the subject by M. von Laue and W. H. and W. L. Bragg. In the second chapter the physical properties of X-rays, scattering, fluorescence, absorption, emission, refraction and X-ray spectra are discussed more comprehensively than in most introductory books on X-ray crystallography.

Part III, *Elements of Diffraction Theory,* comprises five chapters. The concept of the reciprocal lattice is first discussed and then related to the diffraction spectra of single crystals. This approach provides the basis for the entire book and is one with which the reviewers entirely concur. The next three chapters in this part develop the scattering of X-rays by atoms, groups of atoms, ideal crystals and real crystals. Readers who possess only a knowledge of ancillary mathematics should be able to follow the text without too much difficulty. The author has presented the mathematical derivations in a clear manner with accompanying text, where appropriate, to show the individual steps and an Appendix is provided on vector algebra and complex variables. The last chapter in this part deals with crystal structure analysis and is the most unsatisfactory section of the book. Whilst the reviewers realize that in an introductory book of this type a discussion of crystal structure analysis must necessarily be somewhat superficial, we feel that this topic is sufficiently important to merit a separate part on its own. It is impossible in the space of 43 pages to indicate in even introductory detail the basic steps by which the refined crystal structure is derived from the diffraction spectra. A coherent picture of structure analysis is not presented and most of the material in this chapter is not unlike a precis of parts of *Crystal Structure Analysis* by M. J. Buerger, with little attempt to bring it up to date.

Part IV, *Elements of Experimental Methods,* consists of nine chapters describing the production and detection of X-rays and how their interaction with crystals can be studied experimentally. Photographic and diffractometric methods of intensity data collection are thoroughly surveyed, together with the powder method and its use in the identification of unknown materials. A final chapter deals with studies of texture, crystallite size and residual stress analysis.

Throughout the book the quality and content of the diagrams and photographs are excellent. This is particularly true of part IV. Each chapter is terminated by a short bibliography and exercises for which answers are provided in an Appendix. The exercises have been selected to illustrate and extend the contents of each chapter and are suitable for the student working without supervision.

In conclusion, we feel that the book may be of limited use for undergraduate students but is highly recommended reading for research workers who use crystallographic techniques.

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