Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS2 9JT, England). As far as practicable books will be reviewed in a country different from that of publication.

Quantum theory of the solid state (Parts *A* and *B*). By J. CALLAWAY. Pp. xi + 369 + 10 (part *A*) and xiii + 371–824 (part *B*). London: Academic Press, 1974. Price £20·95 each part (Student edition £13·85 parts *A* and *B* combined).

This pair of texts sets out to describe the concepts and methods of the quantum theory of solids but the reader will be faced at once with the problem of the resulting level of sophistication. The claim is made that the books can be used for students who have completed a one-year course in quantum mechanics and who are familiar with the basic experimental facts of solid-state physics, but it should be appreciated that this is a training book for the professional solid-state theoretician and that the quantum mechanics course ought to be at postgraduate level. As such, it stands in comparison with texts such as those by Harrison, *Solid State Theory*, Taylor, *A Quantum Approach to the Solid State*, Kittel, *Quantum Theory of Solids*, or, more recently, Ashcroft and Mermin, *Solid-State Physics*. With much of the sparseness of Kittel, in its hardback format it finds itself priced far beyond the sparse specificity of Taylor and furthermore, lacks the easy flow of the descriptiveness of Harrison or of Ashcroft and Mermin. Nonetheless, it does offer a valuable supplement to those texts in carrying an analysis of the phenomena of solid state in language that is much closer to that of the original research papers.

In that aspect, it calls for comparison with Jones and March, *Theoretical Solid State Physics*, also in two volumes and equally ludicrously expensive. Both these texts develop the application of theoretical techniques which the more introductory texts gloss over or frame in a fashion which is not directly that of the original papers; but the distinct difference between Jones and March and the text under review lies in the index. Frequently, in comparing them for coverage and level of treatment, I found myself assuming from the index that some particular topic was not included by Callaway, only to find that closer detailed study of the text threw up that apparently omitted topic. In addition to the training of theoretical solid-state physicists, one of the uses of books at this level of sophistication is to refresh one's understanding of some specific topic, as opposed to reviewing a general area of study. Precisely that is well-nigh impossible in the Callaway work, much to the disappointment of the reviewer. Apart from that, the book offers much the same coverage, with the Jones and March being slightly more discursive for the marginally lower cost of £37 for the pair. Callaway develops the formalism of solid-state physics in the first volume, treating lattice dynamics, magnetic ordering from a phenomenonological point of view, symmetry and its consequences, and energy bands in perfect solids. His second volume applies this formalism to the problems of impurities and of disordered systems, to the response of the solid to external fields and to electron–phonon and electron–electron interactions. The student paperback edition of Calloway brings it into direct competition with the other more introductory texts mentioned above but I, for one, would find them much more approachable sources for learning my advanced solid-state physics.

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Crystal form and structure. Edited by C. J. SCHNEER (Benchmark Papers in Geology, No. 34). Pp. xiii + 369. Chichester: John Wiley, 1977 (for Dowden, Hutchinson & Ross, Inc., Stroudsburg, Pennsylvania). Price £24·00, $38·00.

A benchmark, in surveyors' language, is an established point on the ground, recorded on our maps, and in accordance with the aim of the series of 'Benchmark' volumes, this book is a collection of papers regarded as significant contributions in the development of our ideas on the relation between the shapes of crystals and their internal structure. Beginning with an extract from an essay on snowflakes by Kepler, published in 1611, which may have been the first suggestion of the close packing of spheres as the basis of crystal morphology, the book includes many papers or extracts in which ideas were put forward in the attempt to understand why crystals found in the rocks or in chemical preparations have such remarkable shapes. The papers, all in English (translated where necessary from the originals), are not in chronological order but are arranged in groups, each dealing with a particular aspect of this very complex problem, or approaching it from a different standpoint.

This is a mineralogist's selection in which papers are only included if they discuss morphology explicitly. This definition of the scope of the collection explains what at first sight seems the most surprising omission from a book with this title: there is not a single Bragg paper. Surprising, because the whole history of the subject falls naturally into two parts: the pre-Bragg era in which we find speculations about internal structure based on crystal shapes, and the post-Bragg era in which atomic arrangements in many crystals were definitely settled by X-ray diffraction and provided the essential foundation for a real attack on the problems of crystal morphology. The early Bragg papers indeed could be said to constitute the outstanding 'benchmark' in the whole history of the subject. But the Braggs did not explicitly discuss morphology, so their papers are not included. It remains surprising that there is a section entitled *The first structures* which contains only papers by Barlow and Pope, published in the pre-Bragg era, in which suggestions, based on morphology, of atomic arrangements in simple structures were made.

To those interested in the history of science the early papers make fascinating reading; for many of us, though familiar with the main threads of the subject from textbooks, have never seen the original papers in which the ideas were first presented. There are extracts from the works of Haüy and Bravais, Friedel and Fedorov, in which the idea that the principal faces of crystals are those having a high reticular density of lattice points was developed. But it was realized that other influences would have to be taken into account: the detailed arrangement of atoms in complex structures, the distribution of electrical polarity, the different surface properties of the opposite faces of polar crystals. It only became possible to discuss these in the post-Bragg era, as in the extension of the Bravais principle of high reticular density by Donnay and Harker, who took into account the motif of the space group as well as the Bravais lattice, and the 'periodic bond chains' introduced by Hartman and Perdok as a rough way of estimating the relative attachment energies on different faces. Meanwhile, in the pre-Bragg era there were side-glances at other properties of crystal faces, particularly the surface energies, by Gibbs, Curie and Wulff, who developed the idea of an equilibrium form of minimum surface energy; but only in principle, for until structures were settled by X-ray diffraction there was no basis for the estimation of surface energies.

Consideration of the distribution of forces in perfect crystal structures is still not enough; imperfections, especially screw dislocations, influence the relative growth rates of different faces, and certain solvents and dissolved foreign substances may give rise to quite different crystal habits. Papers by Frank and others on dislocations are included, but although solvent and foreign solute effects are mentioned in general discussion papers by Wells and Buerger, no papers attempting explanations of these effects in terms of structure are included. In contrast to this serious omission, it is surprising to find a section *Morphology in phase space* dealing with Brillouin zones: an inclusion of questionable relevance to the theme of this collection.

Readers may differ in opinion about omissions or inclusions of papers, whether on grounds of relevance or (especially in the case of some recent papers) doubts whether the significance of contributions is great enough to entitle them to be regarded as 'benchmarks'; but on the whole this is a useful collection of papers which covers the subject fairly well, from a mineralogist's point of view. Those concerned with molecular crystals are less well served, for the relation between crystal shape and molecular shape is not considered at all. As Bernal used to say, chemists quite rightly recognize three classes of crystals – needles (flat molecules), plates (long molecules) and chunks (compact-shaped molecules). Perhaps one hardly expects to find this in a book in a geological series. But why not? Hydrocarbons are important minerals which are prominent in our thoughts at the present time.

The price is very high; this is a book for libraries, especially those concerned with the history of science, rather than for individuals.

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Neutron scattering in chemistry. By G. E. BACON. Pp. 186, Figs. 119, Tables 15. London, Boston: Butterworths, 1977. Price £12·50.

A review of this book, by Lynne L. Merritt Jr, has been published in the February 1978 issue of *Acta Crystallographica*, Section B, page 700.

Crystallographic computing techniques. Edited by F. R. AHMED, with co-editors K. HUML and B. SEDLÁČEK. Pp. 502, Figs. 134, Tables 93. Copenhagen: Munksgaard, 1976. Price Dkr 336.00.

This book contains the proceedings of the International Summer School on Crystallographic Computing, which was held in Prague, Czechoslovakia, 28 July–5 August 1975. It covers three main topics: *A*: structure solving methods; *B*: computational aspects of protein crystallography; *C*: miscellaneous crystallographic computer applications and techniques.

Papers in part *A* give chiefly an exposition of the traditionally successful symbolic addition and multisolution methods: the historical development and basic principles of direct methods, containing an interesting note on the computation of cosine invariants (J. Karle), the practical aspects of the symbolic addition procedure with many examples (I. L. Karle), the programming aspects of this procedure (Ahmed & Hall), a clear treatment of the *MULTAN* system (Woolfson) and the description of an automatic system based on the multisolution method (Andrianov & Tarnopol'skii). For the expert crystallographer it is a convenient survey of formulae, procedures and examples to have at hand.

Of the more recent developments in direct methods this book contains a remarkable contribution by Main, who introduced into *MULTAN*, as a systematization of older theories, a procedure that makes use of molecular structure. Apart from this there are some preliminaries on entirely new methods that we may expect in the near future: magic integers (Woolfson), matrix methods (Main) and a heuristic theory on the concept of neighborhoods (Hauptman).

A number of papers in both sections *A* and *B*, cover the subject of partial structure, phase refinement and phase extension in proteins. Sayre's method (Sayre), the maximal-determinant method (Tsoucaris) and the methods that modify the electron density (Gassmann, Simonov, Collins *et al.*) all seem to show a capability of improving the resolution of protein electron-density maps, starting from about 2·5 Å resolution.

Section *B* contains papers on protein crystallography which are also very informative to the general crystallographer: data collection (Bassi), the handling of protein data (Dodson), isomorphous replacement (Dodson, Kartha, Ashida) and anomalous scattering (Srinivasan). The increasing importance of Patterson search procedures, especially for the larger protein structures and viruses, is reflected in papers by Tollin, Blow, Bricogne, Colman *et al.* (see also, for ordinary structures, a paper by Kutschabsky and Reck on the convolution-molecule method in section *B*). The use of molecular structure and of non-crystallographic symmetry, which have always been the basic ingredients of these