and biological applications, including both X-ray analysis and electron microscopy.

The most outstanding feature of the treatment is its authority and extreme lucidity to the non-specialist.

Extensive reference to the original papers is given. One appreciates the critical warnings concerning 'limitations which are not always fully appreciated'. The initiator of the phthalocyanine synthesis rightly stresses the power of the heavy-atom technique and especially that of the isomorphous-substitution method. Perhaps the usefulness of the Patterson method could have been valued a little more optimistically. A chapter like that on the condensed hydrocarbons naturally gives evidence of the author's monumental work.

The Baker Lectures have been enriched by an excellent volume.

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Twinning and Diffusionless Transformations in Metals. By E. O. HALL. Pp. ix+181 with 97 figs. and many tables. London: Butterworths. 1954. Price 30*s*.

All the leading topics within the field of twinning in metals are surveyed in this monograph: geometrical aspects; the homogeneous twinning shear, and concomitant heterogeneous atomic movements, for the various metal structures; experimental methods for determining twinning elements, including Cahn's work on α-uranium; data relating to the formation of twins under stress and by heat treatment; dislocation mechanisms for the growth of deformation twins; the situation at grain boundaries; recent Russian work on the possibility of nucleation by classical elastic stress concentrations. There are preliminary sections on general crystallography, stereographic projection, techniques for the preparation of metal single crystals, and plastic deformation by slip and by kinking. Finally there is a long chapter devoted to martensite transformations (referred to by the author as diffusionless transformations), including Frank's dislocation analysis of the γ–α interface. The book includes several useful tables, in particular the three summarizing the crystallography of slip, twinning, and martensite reactions respectively; these would prove more convenient for reference and comparison if grouped at the end together with appendices. The author's extensive reading of the subject is reflected in the very full lists of both antique and modern references, some of them not readily accessible, which are provided at the end of each chapter.

The chapter on theories of twin formation, concerned almost wholly with dislocations, is something of a disappointment. Only two paragraphs each are devoted to the important papers by Cottrell & Bilby, and by Millard & Thompson; these papers make difficult reading, and could bear the clarification and critical exposition which one looks for in a specialized monograph. The earlier part of the chapter is taken up with an account of the theory of dislocations, beginning *ab initio* and moving rapidly through a variety of topics very indirectly connected with twinning. This material is not required by the research worker, is likely to prove indigestible to the student, and is in any case treated much more satisfactorily elsewhere. Similar considerations are applicable to the first chapter, dealing with the structure of crystals and with the stereographic projection. No useful purpose can ever be served by a hurried treatment of standard material, and the book could be immensely strengthened by eliminating such material and concentrating more fully on later developments.

The various figures meant to illustrate atomic movements have been taken over directly from the literature, but it must be said that they are largely incomprehensible. This defect could have been to some extent remedied by cutting down the excessive number of atomic sites and projections included, and by distinguishing clearly between points arising from a lattice and those arising from its associated basis. People would do well to realize that very carefully thought-out methods of representation are required if twinning diagrams are to succeed in their object.

Compared with slip, or even with the martensite transformation, twinning is a comparatively mysterious phenomenon, and no definitive account of it can be given at the present time. In the circumstances any book on the subject can amount to little more than a loosely strung series of facts and speculations, awaiting the ideas which could render a more unified approach possible. Meanwhile the monograph by Dr Hall is to be welcomed as providing a compact review of our present state of knowledge, useful to the research worker as a book of reference and yet suitable for the post-graduate student as a gateway to a subject both difficult and fascinating.

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Bau und Bildung der Kristalle. By F. RAAZ and A. KÖHLER. Pp. iv+185 with 166 figs. Vienna: Springer. 1953. Price 31*s*.

It is very difficult to understand for whom this book is intended or what purpose is served by its publication. Within the short space of 180 pages an enormous field is covered, but so superficially that the treatment can be of no value to the trained crystallographer. On the other hand it can have little appeal to the general reader because specialized and relatively advanced ideas are freely introduced without adequate explanation or discussion, and in an order difficult to justify on any rational basis. Thus the book opens with an account of morphology and symmetry in which Miller indices are employed, although these are defined and explained only at a later stage. An account of lattice geometry follows and half a page is devoted to space-group theory (the Schoenflies notation is adopted and in the diagrams unconventional symbols are used for the symmetry elements). A brief introduction to X-ray diffraction is followed by an account of the crystal chemistry of the silicates; only after this are simpler structures such as rocksalt, diamond and fluorite considered. Then comes an account of crystal optics (6 pages) in which pleochroism, ray surfaces and dispersion are the topics selected for discussion. Piezoelectricity is considered next and the rest of the book

(except for the intrusion of a chapter on twinning) is devoted to chapters of more specifically mineralogical or geological interest: mineral formation in nature, mineral synthesis, crystal growth (but without any reference to the important recent work on this subject), gem stones, colour, luminescence and fluorescence, the core of the Earth, the occurrence of gold, platinum and iron in the Earth's crust (twice as much space is devoted to this topic as to crystal optics), meteorites, and methods of mineral identification.

In spite of its title and the recommendations on the wrapper, the book gives a distorted picture of the field of modern crystallography. There is no mention at all of the structures of metals or molecular compounds, and the general reader might well be excused if he formed the impression that crystals are to be found only in the mineral kingdom and that their study has been almost exclusively confined to German-speaking scientists.

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The Statistical Approach to X-ray Analysis.

By V. VAND and R. PEPINSKY. Pp. xvi+98. State College: X-ray and Crystal Analysis Laboratory of the Pennsylvania State University. 1953. Price $1·50.

The solution of the phase problem is the rainbow's end which those interested in the theory of crystal-structure analysis have been pursuing for a long time now. The statistical approach of Vand & Pepinsky represents an important step in the right direction. They sensibly refrain from claiming that they have found a pot of gold; in fact an important part of their book is devoted to showing that all is not gold that is published by the American Crystallographic Association. The present research monograph will be read with interest and profit by all concerned with research on crystal structures. It is certain to stimulate further work: in fact the authors suggest enough undeveloped lines of exploration to keep us all busy for a long time.

Part I examines the Hauptman & Karle probability distribution function for interatomic vectors but concludes that the new representation gives little more information than a Patterson function. Parts II, IV and VI demonstrate, both theoretically and by means of numerical examples well illustrated with X.R.A.C. maps, that the Hauptman & Karle method of obtaining signs from the intensity distribution alone, depends, in effect, on equating a crystal structure to a modification of its Patterson function, or the square of the latter, or a section through it. The limitations of this procedure are clearly demonstrated.

Parts III and VIII show how the distribution of U_h and of U_{2h} can be found by a semi-empirical method when the unit cell contains N equal atoms distributed at random. The results presented are most interesting and unexpected; for example for a given value of U_h there is a range of values which U_{2h} cannot assume, quite apart from the well-known restriction imposed by Harker–Kasper inequalities. The way in which Fig. 2 can be obtained from Fig. 1 is unfortunately described in rather a cryptic fashion.

In the remaining sections (there are eleven in all) the authors develop the connection between the 'statistical approach' and the Patterson function, and derive formulae which give the probability that the sign of a structure factor is positive, or that it is equal to the product of the signs of two related structure factors. This is done in some detail for a number of commonly occurring space groups and some very interesting results emerge. Their relation to those obtained by Hauptman & Karle is discussed. A suggestion is made for increasing the usefulness of the conventional Patterson–Harker section.

The text is free from small random errors (apart from a few noted on an errata sheet) and the general style is clear. The same cannot be said of many of the mathematical derivations, however. The authors always treat the mean and the root-mean-square of a function as if they were equivalent. This leads them to make some quite incorrect assumptions. For example, the following objections can be made to the derivation of $P_+(U_{2h})$ on p. 46. (1) The distribution of values of $(U_{2h}-NU_h^2+1)$ is far from gaussian, since U_h has itself a gaussian distribution. (2) The distribution function

$$P = \exp\left[-\tfrac{1}{4}(U_{2h}-NU_h^2+1)^2\right]$$

cannot in any case give the distribution of values of U_{2h} for a fixed value of U_h^2, as is tacitly assumed. To prove this, it is only necessary to put $U_h^2 = 0$, when the distribution P predicts a most probable value for U_{2h} of -1, a value which is contradicted both by experience and the authors' Fig. 2. Nevertheless, the reviewer considers that, by a cancellation of errors, the final expression for $P_+(U_{2h})$ is correct, as after a severe tussle he was able to derive it in another way. The authors have not been so lucky on p. 71. In this case a similarly incorrect derivation has led to an incorrect result, equation (11). A revision of many of the derivations would enhance the value of what is already an excellent piece of work.

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The Crystalline State. III. The Determination of Crystal Structures.

By H. LIPSON and W. COCHRAN. Pp. ix+345 with 305 figs. and 9 plates. London: Bell. 1953. Price 50*s*.*

This book is the third, and probably the final, volume in the series edited by Sir Lawrence Bragg and entitled *The Crystalline State*. It is a worthy companion to its two excellent predecessors in the series: *A General Survey* by Sir Lawrence Bragg, and *The Optical Principles of the Diffraction of X-rays* by R. W. James.

The authors assume that the X-ray diffraction data have been collected, corrected and tabulated, and direct their attention solely to the problems that arise in at-

*Contribution No. 1910 from the Gates and Crellin Laboratories.