points that we use today. Some papers are included which describe how space groups could be found from X-ray diffraction patterns, and how molecular symmetry could sometimes be inferred from the space group of a crystal and the atomic content of its unit cell. Chapter VII presents most of the classic papers in which the ionic and covalent atomic radii are defined and stated. (Metallic radii were also much used in the 1930's, but no paper about them is included.) Then follows some material describing the early work on the structures of ionic crystals, together with some mention of the hydrogen bond. Chapter VIII contains papers, or fragments of papers, describing the various techniques for collecting data on the directions and intensities of X-rays diffracted by crystals, crystalline powders, and partially crystalline fibers. The Laue, powder, rotation, and Weissenberg techniques are described, and some of the structural results so obtained are presented. Chapter IX deals in a similar way with the classic works on solid solutions, random stacking of layers, and rotating groups. Some of the early work on alloys and their structures is also included in this chapter. Chapter X presents a collection of pioneering papers on crystal-structure determination. Early uses of symmetry, cell dimensions, diffracted intensities, chemical intuition, trial and error, and isomorphous replacement are all described. The increasing complexity of the structures studied during the period 1920 to 1935 is clearly brought out. The chapter ends with the first papers on X-ray diffraction by crystalline proteins. Chapter XI is a group of papers in which is traced the history of the use of Fourier series in crystal structure determination. It starts with the working out of the electron density in alkali halides, continues with the use of signs from trial structures, and ends with the heavy-atom method. Chapter XII contains only one paper: the famous 1935 paper fully explaining the Patterson method, then – tacitly – limited to finding the projections of interatomic vectors onto lines or planes.

The names of the authors of all these great papers are not quoted above; to do so would have made this review too long. The distinguished names are all in the book, of course, and most of them are familiar to every physical scientist.

An interesting example of the discovery, loss, and rediscover of an important idea appears on the title page of Chapter XII. P. P. Ewald pointed out in 1921 that the squared magnitudes of the structure amplitudes of the X-rays diffracted by a crystal depend on the interatomic vectors and not the atomic positions. No use seems to have been made of this fact until it was rediscovered by A. L. Patterson in 1934.

By carefully reading the material in this book, a student could learn more than three quarters of what a modern X-ray crystallographer should know, and at the same time get a feeling for the excitement that existed among investigators of crystal structures in those thrilling days. He would also discover how incorrect ideas are sometimes held by very distinguished scientists, and how subsequent thought and experiment changes these ideas into others. Eventually the current ideas are evolved; these are the ones we think are correct.

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Crystal structure determination. By HERBERT A. HAUPTMAN. Pp.xii+407. New York: Plenum Press. 1972. Price $23.00.

Significant advances in the practical use of formalized direct methods for determining more and more complex atomic structures bring not only a sense of achievement but also a feeling of loss. The thrill of searching for an intricate atomic pattern guided primarily by the investigator's intellect will never return. Computer-controlled diffractometers and powerful computers on which the modern methods for solving the problem of structure analysis are being programmed allow automation of the whole process of the determination of the atomic structure of crystals. With structure determination turned into a routine process mineralogists, chemists, physicists and specialists in molecular biology can use structure analysis as an effective method in their everyday research.

In recent years the number of structures established by direct methods has steadily increased. In these methods two approaches can be considered as the most effective ones: symbolic addition and the multiple-solution method.

The subject of this monograph is concerned with a third approach which is based on the systematic use of structure invariants and seminvariants. At the present time this approach does not seem to have as many successes to its credit as the other two, but the examples of its practical use as presented in the final chapters of H. A. Hauptman's book give a good idea of the potential development of this method.

The monograph is divided into three parts: in the four chapters of the first part an attempt is made to expound the theoretical bases of the method. The treatment of the algebraic formulae for deriving structure seminvariants is given fully. This section of the book closes with an account of the probability approach to the phase problem in structure analysis. The techniques of implementation of the theoretical methods described in the first part of the monograph are thoroughly discussed in the second part. The algorithm for solving the phase problem is divided by the author into three more-or-less independent stages – the calculation of cosine seminvariants from the values of the moduli of normalized structure amplitudes, the determination of phases of a small number of the basic structure amplitudes, and finally the establishment of the phases of a sufficient number of structure amplitudes sufficient to reveal an approximate structure in an E map.

The sections in which the criteria for selecting the structure enantiomorph are given attract the reader's particular attention. This new approach to enantiomorph discrimination is based not by fixing the phase of one selected reflexion, but through the selection of two groups of reflexions for such an identification. This idea seems useful for any of the variants of direct methods.

The most important stage in applying direct methods is the establishment of the phases of a small number of basic structure amplitudes. A least-squares method is here described by which a set of phases in best agreement with the derived cosine seminvariants is readily selected.

The application of the tangent formula for refining and extending phase information is now a generally accepted procedure in direct methods. Hauptman discusses possible modifications of this technique and gives a number of examples which illustrate the advantages of the proposed modifications. A good part of the book is devoted to the

detailed description of the determination of a number of rather complex crystal structures. Chapters X, XI and XII of the third part are written by C. Weeks. Together with the exercises introduced by the author in the theoretical part of the monograph, there are practical examples in the final chapters which turn the monograph into a very useful textbook for mastering this new variant of direct methods. The idea of application of cosine seminvariants to crystal-structure determination, which appears to be worked out in a rigorous and systematic manner, brings us nearer to the stage where the calculation of the phases of structure amplitudes from X-ray diffraction experimental data will become a routine procedure. Following the monographs by H. Hauptman and J. Karle, *Solution of the Phase Problem*, New York, 1953; by A. I. Kitaigorodskii, *Theory of Structure Analysis*, Moscow, 1957; and by M. M. Woolfson, *Direct Methods in Crystallography*, Oxford, 1961, the book under review is undoubtedly an important contribution to the development of the theory and application of direct methods of crystal-structure determination.

In conclusion, the reviewer would like to say that it is perhaps regrettable that no references are found to the above mentioned monographs by Kitaigorodskii and Woolfson as well as to the works of I. M. Rumanova [*Dokl. Akad. Nauk SSSR*, (1954), **98**, No. 3, 399], S. V. Borisov, V. P. Golovachev & N. V. Belov [*Kristallografiya*, (1958), **3**, No. 3, 269] and to some other works which are important for understanding the development of direct methods. Because of this, the bibliography at the end of the book appears to be rather impoverished.

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Phase transitions and critical phenomena, Vol. 1. Edited by C. DOMB and M. S. GREEN. Pp. 506, 105 Figs., 4 Tables. London and New York: Academic Press, 1972. Price £ 10·00.

This book is the first of a series of volumes whose aim is 'to present a coherent account of all that is definitely known about phase transitions and critical phenomena and to provide a standard reference for some time to come, particularly for graduate students'. At present two volumes have been published and two more are in preparation. This volume is subtitled 'Exact Results' and comprises a collection of eight specially invited papers.

A brief introductory chapter by C. N. Yang on the historical development of the subject is followed by a chapter by R. B. Griffiths entitled 'Rigorous Results and Theorems'. The idea of the thermodynamic limit is introduced and its existence in the case of the Ising models of the ferromagnet and the lattice gas is proved. The remainder of the chapter surveys a number of topics such as the conditions for the existence or otherwise of phase transitions in one- and two-dimensional lattices and the inequalities relating various critical-point exponents.

Following chapters on Dilute Quantum Systems and C^* Algebra by J. Ginibre and G. G. Emch respectively, the topics of one- and two-dimensional systems are taken up again. The detailed discussion of one-dimensional lattices and their partition functions by C. J. Thompson may seem somewhat out of place when it is realized that phase changes occur in one-dimensional systems only in the exceptional cases of particular long-range interactions. However the susceptibility of one-dimensional models to exact analysis makes them a useful illustration of the statistical-mechanics method. The chapter on two-dimensional Ising models by H.N.V. Temperley includes a description of what is still the most famous exact result in the theory of phase transitions: Onsager's solution to the two-dimensional Ising model. This solution is described in some detail and its mathematical implications are discussed. The final two chapters of the book discuss the transformation of Ising models (I. Syozi) and the analysis of two dimensional 'ice-like' ferroelectric models (E. H. Lieb and F. Y. Wu). This last chapter which occupies nearly one third of the book, describes a number of two-dimensional problems with directed bonds, whose partition functions can be evaluated exactly and whose critical behaviour can thereby be predicted.

This book is not one in which crystallographers should expect to find theories which will explain their experimental results on, for example, structural phase transitions in crystals. It is significant that none of the well known names of the experimental or theoretical workers in the Edinburgh lattice-dynamics group appear in the extensive list of references, even although one third of the book is devoted to a study of (albeit two-dimensional) ferroelectric lattices. This serves to emphasise the dichotomy between those who are looking for a theory which will explain their experimental results and those who are looking for models capable of rigorous theoretical investigation; it is to be hoped that future volumes in the series will attempt to bridge this gap. In the meantime the mathematically well equipped graduate student or research worker who wishes to study a rigorous treatment of the theory of phase changes could well find this book useful.

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Practical methods in electron microscopy. Vol. 1. Edited by AUDREY M. GLAUERT. Pp. viii + 444, 211 Figs., 8 Tables. Amsterdam: North Holland, 1972. Price *f* 110.00 (*ca.* US $34.50).

This book, as its title implies, is essentially directed at research workers who want to know exactly how the various operations in electron microscopy are carried out. It is written by people who have intimate knowledge of the subject, and, in addition to full descriptions of experimental detail, lists of suppliers of necessary items – ranging from electron microscopes themselves to storage boxes for specimens – are given at the end of each section.

The format of the book is rather odd. It is three books in one, and the first part has its own appendices and index. The second part has two sections, each with its own chapter numbering, but with appendices at the end of the first section and index at the end. Thus the book has three Chapter 1's, for example. It is all very confusing and makes cross-referencing very difficult.

The subjects treated are specimen preparation, inter-