crystallographers who developed the subject in the last century. However, whereas the reviewer held uppermost the problem of placing the subject in a form that might be useful for application in quantum mechanical calculations, Burckhardt has mathematical completeness and elegance in mind, and as a result goes much farther along the road of refinement. His goal in brief is to place the crystallographic groups upon the same plane as that on which Speiser placed the general theory of finite groups in his well-known book. He is eminently successful and may as a result have placed his work out of the orbit of the more literal minded crystallographers who find a complete understanding of the visual geometrical development necessary for the everyday problems of the field.

The book is divided into three large chapters which discuss, respectively, the point lattices, the crystal classes and the space groups. The opening sections present the elements of linear algebra and matrix theory and thereby set the mathematical background of the work. Great care is taken in this presentation to establish the position of the crystallographic groups among the family of groups. Most of the discussion is valid for a space having an arbitrary number of dimensions.

The second chapter, which deals with the crystal classes or point-groups starts again with a formal mathematical discussion of the subject. However, the formal reasoning is soon applied to the two-dimensional net both to give concrete working examples and to derive the conditions which restrict the purely rotational point operations to rotations through 0°, 60°, 90°, 120°, etc. The complete two-dimensional groups are presented and the discussion is then extended to the three-dimensional classes. Burckhardt employs Schoenflies' notation for all of the three-dimensional groups and tabulates the results in a mathematical form that is quite useful, namely as a code from which the symmetrically equivalent points may be derived in either rectangular or hexagonal Cartesian co-ordinates. For example, the group D_4 is expressed in the form

$$D_4 = C_4 + (x, \bar{y}, \bar{z})\ C_4 = D_2 + (y, \bar{x}, z)\ D_2$$

to indicate first that D_4 may be generated both from C_4 and D_2 by augmentation with suitable generating elements, and second that the equivalent points of D_4 contain, in addition to those of C_4 and D_2, the points obtained by allowing C_4 to act upon the point $(x, \bar{y}, \bar{z})$ in the first instance or upon $(y, \bar{x}, z)$ in the second. The equivalent points of the Abelian groups, which contain only powers of a single element, are tabulated explicitly.

The second chapter closes with the development of the fourteen translation groups and their point-symmetry.

The third chapter contains a development of the space groups. Again, the chapter starts with a formal presentation of the mathematical theory of the groups and uses the two-dimensional case both for illustrative purposes and to provide a method of approach to the three-dimensional problem. The three-dimensional space groups, like the classes, are expressed in a form that makes it possible to derive the sets of equivalent points within the unit cell, Schoenflies' notation being used throughout.

The third chapter ends with a twenty-page discussion of the mathematical features of the space groups in n-dimensions.

It is the reviewer's opinion that all but the small group of readers who enjoy formal mathematics for its own sake will find the book less readable than Schoenflies' original work on the subject. On the other hand, its conciseness would probably make it a suitable reference text for anyone brave enough to attempt a series of lectures on the theory of the space groups. On the whole, the book will undoubtedly find a place of permanent value in the literature of the field.

Unfortunately, the writer has not attempted to discuss the phases of the theory of the crystallographic groups which centre about the work of Schur and which have proved to be so valuable for quantum physics when placed in the hands of Wigner and Weyl. The subject of reducibility is touched upon at several places in the book, but always in a rather specialized manner that is of interest primarily for the discussion at hand. Theoretical physicists will not find the present book useful if they are looking for something in the nature of an additional chapter to the books of Wigner or Weyl. Perhaps Burckhardt will oblige this potential audience with a second volume, extending the subject in this direction, at some time in the future.

Anyone with scholarly inclinations who has found his life seriously interrupted by the events of the last two decades will undoubtedly be touched with an air of wistful envy as he turns the pages of this book, for it exudes the spirit of classical academic leisure. To this reader Burckhardt offers advice in the words of Kepler: 'When the storm rages and society threatens to founder, we can do nothing that is of more value than to sink the anchor of our peaceful study into the grounds of eternal science.'

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Les Rayons X et leurs Applications. By H. BRASSEUR. Pp. 366+xlvii, with 257+36 figs. Editions Desoer, Liège, 1945. Price, 595 Belgian francs; 31*s*.

This book is a general survey of the applications of X-rays and covers a very wide field. The first 50 pages are devoted to a brief account of the production and properties of X-rays. Then follow 40 pages in which the author covers medical radiology, industrial radiography and chemical analysis by the methods of absorption- and emission-spectra. The rest of the book deals with diffraction methods under the following main headings:

	No. of pages
1. The atomic scattering factor	5
2. Study of molecular structure in gases	18
3. Diffraction by liquids and solutions	25
4. Diffraction by monoperiodic substances	8
5. Diffraction by crystals	
(*a*) Determination of crystalline structure	176
(*b*) Results of crystal-structure work	36
6. The structure of glass	8
EXERCISES (on some diffraction methods)	31

Under the various sub-headings of 5 (*a*) a brief account is given of crystal symmetry, of various methods of structure-determination, and of the methods of taking X-ray photographs—rotation, powder, Laue, fibre, but not moving-film methods. Under each method a survey of the chief applications is given.

The book is well printed on excellent paper and most of the illustrations are good. The reproduction of the powder and rotation photographs of Figs. 6–13 (p. viii of Exercises)

is very good, but it is irritating to have to search in the text for the relevant data which are actually distributed over five different pages. A very full table of contents is given, but the mixture of small and capital letters, italic letters and two kinds of numbers is both confusing and inelegant. But even a detailed table of contents does not make up for the lack of an index. It is high time that in this respect the writers of scientific books in French followed the practice of their colleagues who write in other languages.

Since so high a proportion of the book is devoted to crystallographic methods and applications it is not, perhaps, unfair to judge it mainly from this point of view. It is a little difficult to envisage the group of readers for which the book is intended. The addition of exercises at the end seems to show that it is intended as a manual for the student and the research worker. But the vast field covered in the text makes it impossible for the author to give a sufficiently detailed discussion on any topic for this to be of much use to the student. The exercises themselves are rather curious. Those on the use of the stereographic projection for the interpretation of fibre photographs are good, but those on powder photographs are inadequate for this very important method. The exercise on the use of the rotating-crystal method covers only the determination of the repeat distance along the axis of rotation, and there is no exercise on the method of indexing an oscillation photograph.

On the other hand, if we disregard the exercises, we could consider that the book is intended as a general survey from which a worker in one part of this field could gain a wider knowledge of the field as a whole. From this point of view, however, most of the descriptions of methods are difficult reading, as for example, the methods of structure determination based on Fourier series. Also, a sketch of crystalline symmetry is given which is either incomprehensible or unnecessary, according to the amount of knowledge of this subject possessed by the reader. In a survey it would surely be better to give a general description of symmetry, illustrated by analogies, rather than to introduce the technical nomenclature without having the space to explain it properly. The section on the structures of crystals is very compressed and is inferior to accounts which exist in English; it can perhaps be justified by the non-existence of any other recent general account of this subject in French. In this section, as in the others, the style of writing is clear and the material is well laid out, but the book as a whole does not seem to have behind it any clear purpose, and it certainly tries to cover far too wide a field for the present stage of development of X-ray studies.

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Los Rayos X y la Estructura fina de los Cristales. Fundamentos teóricos y métodos prácticos. Par J. GARRIDO et J. ORLAND. Pp. 260 + xiii, avec 238 figs. Editorial Dossat, Madrid, 1946. Prix 148 pesetas.

Le livre qui viennent de publier MM. J. Garrido et J. Orland est très différent des nombreux ouvrages parus jusqu'à ce jour, sur la structure atomique des cristaux déterminée au moyen des rayons X. Il a été constitué, en majeure partie, d'articles parus dans les *Annales de Mécanique et d'Electricité* de Madrid. Je ne doute pas qu'il soit très utile au public auquel il s'adresse, qui est celui des étudiants de recherche. Ceux-ci y trouveront à la fois les bases théoriques et les méthodes pratiques qui leur permettront de réaliser sur un cristal les diagrammes de rayons X, de les interpréter et de fixer la position des atomes; et ceci, d'autant plus facilement qu'il contient, avec une abondante bibliographie, des exemples pratiques nombreux dont les calculs sont poussés jusque dans le détail. Cet ouvrage est donc à la fois un exposé théorique de la question et un manuel de travaux pratiques.

Il comporte trois parties: les deux premières, de développement égal, traitent des 'principes généraux' et de la 'détermination de la structure cristalline'; la troisième, plus courte, est un exposé de quelques résultats.

La première partie comprend des généralités sur les rayons X et la structure des atomes; la théorie de la diffusion des rayons X par des électrons libres et les atomes; les principes de la cristallographie géométrique; enfin, un développement plus important de la diffusion des rayons X par les cristaux où l'on utilise largement le réseau réciproque. Elle se termine par l'étude de la diffusion des rayons de Roentgen par les ondes d'agitation thermique.

La seconde partie concerne les méthodes de réalisation des diagrammes de rayons X, et marque les étapes qui, de la mesure des paramètres aux séries de Fourier, conduisent aux structures atomiques. Un chapitre est consacré à l'étude détaillée des structures du cuivre, de la brucite, $Mg(OH)_2$, du rutile, TiO_2 (développement en série de Fourier), et de la manganite, MnO(OH).

On est d'abord un peu surpris par l'hétérogénéité de la troisième partie; c'est d'abord un exposé succint de chimie cristalline, celle des éléments, puis celle des différents groupements d'atomes qui se rencontrent dans les cristaux; enfin, une étude de l'orientation des cristallites dans les textures cristallines. Mais cette surprise cesse quand on se rappelle que l'ouvrage a été constitué à partir d'articles publiés dans une revue.

On trouve à la fin du livre des tableaux donnant les valeurs de $\sin 2\pi p$; $\cos 2\pi p$; $\cos 2\pi hx$; e^{-x}; les coefficients d'absorption des éléments; les facteurs atomiques.

L'ouvrage présente ainsi un aspect complet des problèmes que pose la détermination des structures atomiques à l'aide des rayons X. Je regrette seulement que dans ce livre important le paragraphe concernant les développements de la densité électronique par les séries de Fourier ait été aussi rapidement traité. Par contre, dans cette période de pénurie et de restrictions, on est heureux de consulter ce livre, de 244 pages, bien imprimé sur beau papier, abondamment illustré, avec des tables de matières et d'auteurs commodes. Il fait grandement honneur à MM. Garrido et Orland.

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