katrix allein befriedigend gelöst werden können, sondern sie wirken nach den Erfahrungen des Referenten auf den Anfänger auch verwirrend.

Die ganze Behandlung vermeidet mathematische Formulierungen mit Ausnahme der (z. T. durch Druckfehler entstellten) Gleichungen der Bezugsflächen. Man kann sich prinzipiell fragen, ob dieser Standpunkt beim derzeit erreichten Niveau der mathematischen Mittelschulbildung noch notwendig oder auch nur zweckmässig ist, besonders wenn man in Betracht zieht welche Anforderungen auch in einführenden Vorlesungen in Physik oder physikalischer Chemie heute ganz allgemein gestellt werden. Selbstverständlich darf man nicht ins andere Extrem verfallen, aber für den Referenten besteht kein Zweifel, dass z. B. das Verhalten einer anisotropen Kristallplatte zwischen gekreuzten Nicols durch eine elementare Diskussion des bekannten Fresnel'schen Ausdruckes prägnanter und klarer dargestellt wird als durch noch so viele blosse Worte. Die Verwendung mathematischer Formulierungen in bescheidenem Ausmasse scheint auch deshalb für einführende Darstellungen angezeigt, weil dadurch dem Leser der Uebergang zu grösseren Werken oder zur Spezialliteratur wesentlich erleichtert wird und er den Anschluss besser findet.

Zu rühmen an dem Buche sind die zahlreichen zweckmässig konzipierten und korrekt in schiefer Parallelprojektion konstruirten Figuren, von welchen einige direkt als vorbildlich zu bezeichnen sind.

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X-ray Studies on Polymorphism. By T. ITO. Pp. 236, with 100 figs. Tokyo: Maruzen Co. Ltd. 1950. Price $10·00.

During the past ten years, Prof. Ito and his students have been actively engaged in the study of mineral crystal structures, and the results of this work are now reported in a series of papers which are collected in this volume. In view of the difficult circumstances under which the work has been done, the amount and character of information presented is truly astonishing. Actually, the title page places too much emphasis on the topic 'polymorphism', since there is no discussion of this important subject beyond the demonstration of the close structural relationship between different polymorphs in several cases, and the methods by which these relationships were made use of in the crystal-structure analyses. These cases are collected in the body of the symposium, and several other structures (the last six listed below) are collected in an appendix of equal extent. The crystal structures described are: eudidymite and epididymite, $HNaBeSi_3O_8$; α-celsian, $BaAl_2Si_2O_8$; enstatite, $MgSiO_3$; anthophyllite, $Mg_7(Si_4O_{11})_2(OH)_2$; epidote and zoisite, $HCa_2(AlFe)_3Si_3O_{13}$; boleite, $26PbCl_2.24CuO.9AgCl.27H_2O$; wollastonite and parawollastonite, $CaSiO_3$; tourmaline, $NaLiAl_8B_3Si_6O_{27}(OH)_4$; kotoite, $Mg_3B_2O_6$; lievrite, $CaFe_3Si_2O_8(OH)$; antigorite, $Mg_3Si_2O_5(OH)_4$; ludlamite, $Fe_3(PO_4)_2.4H_2O$; orpiment, As_2S_3.

Of greatest interest among these structures are the silicates, since several new types of SiO_4 linkages are revealed. The peculiar imbricated sheet structures of epididymite and eudidymite have been published by Prof. Ito previously; in α-celsian is found a sheet structure obtained by inverting one mica-like Si_2O_5 sheet over another and joining them at the apices (the analogy of this structure to the feldspars drawn by Prof. Ito seems a little farfetched); mixed SiO_4 and Si_2O_7 groups are postulated in epidote and zoisite (reminiscent of vesuvianite—but see below); threefold rings in the wollastonites and the polar sixfold rings in tourmaline. The book as a whole contains may new discoveries in coordination chemistry, and represents a truly original and valuable contribution to mineralogy and crystal chemistry in general.

In the analysis of a crystal structure, after the lattice constants and symmetry are established, two phases of the work may be recognized. The first is the one in which the key is sought with which to unlock the secret of the structure, leading to an approximate model of the true structure itself. The second involves the refinement of the structure, in order to determine accurate interatomic distances. This book bears eloquent testimony to Prof. Ito's genius in the first phase. To such a worker as this, structures like orpiment and ludlamite are routine, while we cannot help but be impressed with his solutions of problems such as the boleite structure. But, unfortunately, the second, refinement stage of most of these structures leaves much to be desired. To test the quality of a structure determination we may use various criteria, such as reasonableness of interatomic distances, quality of electron-density mapping, but preferably, where possible, the reliability index, *R*. Many of these structure determinations are based upon intensities characterized only as strong, medium and weak, and we can only judge by the bond lengths reported. Thus, in α-celsian, we observe that Si–O distance are found to be 1·57 and 1·71 Å; since there is good reason to believe that Si–O distances in one tetrahedral group will generally be nearly equal, the error in oxygen location, at least, is probably ±0·07 Å. Examination of bond-distance tables for other structures shows that atomic positions carry errors generally of the order of ±0·05–0·1 Å. Such tables must be regarded as very approximate. In particular, the wollastonites should certainly have a more rigid treatment.

Where intensities are measured photometrically or with the ionization spectrometer, there is more opportunity to increase the precision of structure parameters. Although Prof. Ito did not calculate the reliability index for any of the structures, we may use this test where he tabulates observed and calculated intensities. Values obtained from his data are as follows:

		R
Eudidymite	(13 pinacoid reflections)	0·28
α-Celsian	(13 000*l* reflections)	0·31
Enstatite	(107 *h*0*l* reflections)	0·24
Boleite	(19 pinacoid reflections)	0·17
Kotoite	(13 pinacoid reflections)	0·23
Epidote	(126 *h*0*l* reflections)	0·46

The epidote structure attracted some attention when Prof. Ito published on it (Ito, 1947), but that structure (a complex chain linkage) has been abandoned in the present report in favor of an entirely new one, consisting of mixed SiO_4 and Si_2O_7 groups. Twenty-two pinacoid reflections given for the 1947 structure yield $R = 0·29$. Clearly, the crystal structure of epidote is still an entirely

open question. The important case of tourmaline is also an interesting one, in light of more recently published papers on the structure by Donnay & Buerger (1950), and Ito (1951). Both workers have used the classic method of refinement, by reading atomic coordinates from a Fourier map. Each has arrived independently at what is undoubtedly the correct structure, but refinement cannot proceed beyond $\pm 0{\cdot}05$ Å by such a method based on a projection 7·2 Å deep. Recourse should be made to three-dimensional methods (with appropriate series-termination corrections) or differential methods; perhaps a least-squares analysis would be the most direct method.

Finally, at the end of the book is a detailed discussion of a procedure for indexing a triclinic powder pattern. The procedure consists of indexing the pattern on an arbitrary unit cell, based on three lines of low angle (representing three non-coplanar reciprocal lattice vectors), followed by a series of ingeniously symbolized systematic transformations after Delaunay, to find the proper unit cell for a triclinic, monoclinic or orthorhombic (or higher symmetry) lattice. The method is illustrated by application to two known crystals, and appears to be complete and straightforward, though its success admittedly requires very accurately determined spacings. The practicability of such techniques as this can only be proved, however, by its successful application to several unknown examples.

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Geometrische Kristallographie und Kristalloptik. By F. Raaz and H. Tertsch. Pp. x + 215, with 260 figs. Vienna: Springer. 2nd ed. 1951. Price 32*s.* 6*d.*

The science of crystallography has nowadays so many diverse applications that a sound knowledge of the subject is rapidly becoming indispensable to an ever increasing number of scientific workers both academic and industrial. Although the emphasis has passed from the purely morphological to the structural aspect, it is unsatisfactory for the student to go straight into the study of the principles of structure analysis without the initial discipline of a course in morphological and optical crystallography. For this purpose an introductory textbook, such as this, provides an admirable approach.

The second edition is practically a reprint of the first, which appeared in 1939. It is divided into two parts: the first, by Prof. Raaz, deals mainly with morphological crystallography, and occupies 123 pages; the second, by Prof. Tertsch, consists of only 85 pages, and deals with the optical properties of crystals. The general arrangement of each part follows orthodox lines. After the discussion of axes, indices, zones, stereographic and gnomonic projections, crystal symmetry and the systems with their classes, the first part ends with a short description of twinning and a very concise historical summary of ideas on crystal structure. In the descriptive section of the crystal classes, iodosuccinimide (p. 68) is used to illustrate class C_s^v–*4mm*. This is correct according to the outward symmetry shown in Fig. 74, but the substance has now been placed in class C_4–4 on structural grounds.

The second part of the book is exceedingly concise, most aspects of theoretical crystal optics being dealt with, together with outlines of the optical methods; these including not only microscopical ones, but those also in which polished plates and prisms are used. Brief sections are devoted to the effects of temperature and pressure on optical properties.

It is a pity that in this edition the optical part could not have been expanded somewhat to give more practical guidance in the technique of determining optical properties. A little over one page is all that is devoted to immersion methods; about two pages are given to a description of the polarizing microscope; and—not so serious in an introductory text—two and a half pages to a description of the construction and use of the 4-axis Federov Universal Stage. These are minor points however. The book is otherwise excellent; it is clear, concise, has a good range, is very legibly printed and (although some of the diagrams are rather small) is well illustrated, especially in the morphological section.

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Der Ultraschall und seine Anwendung in Wissenschaft und Technik. By L. Bergmann. Pp. xi+748, with 460 figs. and 83 tables. Zürich: S. Hirzel Verlag. 5th ed. 1949. Price 50 Swiss francs.

This well known book, now in its fifth edition, stands completely apart in its field; it is so much better and so much more complete than other books on the same subject that one is tempted to call it *the* book of ultrasonics.

As in the preceding edition, the book is divided into two parts: the first deals with the production and the measurement of ultrasonics; the second is devoted to applications. It is impossible, in this short review, to give an idea of the wealth of material, scientific or bibliographic, contained in these 750 pages. Let us simply list a few of the applications covered thoroughly: velocity and absorption of ultrasonics in liquids, gases and solids; ultrasonic stroboscopy; material testing; application to communications techniques; coagulation and dispersion produced by ultrasonics; cavitation; chemical, thermal, biological and medical action of ultrasonics.

This new edition has been brought fairly up to date; for instance, its description of the use of the pulse method is adequate. It contains a very remarkable series of photographs (between crossed nicols) of vibrating glass rods. The reviewer found it worth while to devote some time to the contemplation of their beauty, their symmetries and the elaborate nature of their patterns. The sort of delight one gets thus is too rare in modern physics to pass unnoted.

One sometimes may wish that Bergmann had been more critical instead of retaining an aloof and purely de-