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Book Review

A journey into reciprocal space: a crystallographer's perspective, 2nd ed.

by Anthony Michael Glazer, IOP Science, Bristol, 2021, 274 pp., 145 Euro, ISBN: 9780750338752 (Hardback)
Scope: Textbook. Level: Undergraduate, advanced Undergraduate, postgraduate, early career researcher, researcher

A Journey into Reciprocal Space: A Crystallographer's Perspective, second edition by Michael Glazer follows a series of similar books by the same author on space groups and crystallography. True to its title the book focuses on the concept of reciprocal space and its applications to solid-state physics. Written by a leading crystallographer, currently Emeritus Professor of Physics at the University of Oxford and former Vice-President of the International Union of Crystallography, the book reflects the author's complete proficiency in the subject. His efforts in elucidating the relationship between the physical properties of crystals and their structure, together with the lifelong experience in teaching crystallography, make this a very useful, pedagogically written book. The style of writing will particularly appeal not only to students but also to the practicing physicists wishing to brush up the key concepts of crystallography as applied to their day-to-day research.

The book starts with the crystallographer's perspective of direct and reciprocal space to then switch to the point of view of the solid-state physicist. The difference is that, while for the crystallographer the reciprocal space is the standard tool to deal with diffraction, for the physicist it is a useful device to describe the formation and motion of waves, including, e.g. spin-density- and charge-density waves. This view of phenomena in terms of momentum or wave-vector k-space is well suited to periodic structures, such as standard crystals, whose elementary quantum excitations, e.g. phonons and quasiparticles, can be described both as particles and waves. In fact, periodicity and symmetry, which both lie at the heart of condensed matter physics, are the leitmotiv of the book. Now in its substantially revised and expanded second edition, the book is not so concise, yet still readable and up to the point.

The covered material is divided into seven chapters (and a number of appendices).
The first two chapters provide the necessary terminology and knowledge required to understand the direct- and the reciprocal space, and include standard topics, such as point-group symmetry, crystal structure, and space groups. The use of italics to emphasise key concepts is both useful and praiseworthy, while common misconceptions are thoroughly clarified with detailed examples.
The following chapters deal with the physical manifestation of the concept of reciprocal space, starting with chapter three, dedicated to diffraction. After introducing standard concepts, such as the Ewald sphere, Fourier transformation, the form- and structure factors, it ends up with more advanced topics, such as anomalous dispersion, aperiodic-, and partially-ordered crystals. Chapter four is dedicated to dynamical diffraction and treats multiple scattering and Darwin's dynamical theory.

Finally, in the next two chapters, the physicist's point of view becomes dominant. Thus, chapter five, which deals with waves in periodic media and introduces the concepts of Brillouin zone and Wigner-Seitz cell, is followed by their applications in chapter six, whose topic are thermal and electron properties. These include the heat capacity and lattice dynamics, as well as heat conduction and phonon dispersion, to conclude with the tight-binding and nearly-free description of electrons in materials. Finally, the last chapter (new to the second edition) deals with distortion modes, a topic investigated in detail by the author.

Since the book is dedicated explicitly to the reciprocal space, it is perhaps more suited to the students who have already been exposed to the basic concepts of crystallography [1-3]. This impression is reinforced by the presence of more advanced topics, useful to both advanced undergraduate- and graduate students of condensed matter physics.

At times there are a bit too many idiomatic expressions (such as government health warning) and not so relevant and/or obscure quotes (such as those on D. J. Trump, undergraduate parties, etc.), as well as amusing mistakes (the birthday of von Laue is reported as 1979(!), well after his 1914

Nobel prize for X-ray diffraction by crystals). The language perhaps is not the most suitable for an international readership, which might lack the background and the command of English of the typical British student.

On the positive side, besides the careful didactic explanations and the clear figures, there are also numerous warnings to the often confusing and most easily misunderstood points. This is the result of many years of teaching the subject, which gives the author the privileged position of knowing and being able to correct the most common mistakes and misconceptions encountered in crystallography. For instance, the lattice is only a mathematical device, not to be confused with the real crystal structure. Or, further on, the restrictions on the lattice parameters are a consequence of symmetry, while the opposite is not necessarily true. Or, yet again, trigonal refers to a crystal system, not to a lattice system, etc.

Overall, the book is authoritative, but not pedantic. The typical error made by scholars is to forget how to address the undergraduate student. This instead is a thoroughly didactic book, written with the student's need in mind, yet containing the know-how and the experience of someone working for long time in the field. In addition, this is a richly illustrated work, with a detailed series of appendices, useful also to the practising researcher and to those needing a systematic overview.

To conclude, the author's passion for crystallography shines throughout the book and even more so when reading that "the International Tables for Crystallography, vol. A is one of the most outstanding books produced in the 20th-21st centuries"! Such enthusiasm for the subject is highly contagious and it should make this brief journey into reciprocal space a pleasant and rewarding experience also for the reader.

References

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