actors. The cell method of Amouyal, Benoist and Horowitz is also developed in some detail.

It should be noted that this text contains no development of neutron transport theory, as based on the Boltzmann equation. I would think that a chapter including such a development would have been worthwhile; it could show how diffusion theory is an approximation to transport theory and how this approximation may be improved upon in a systematic fashion. In fairness, however, Lamarsh does rather clearly describe the limitations of diffusion theory and he uses collision probability methods and not diffusion theory for treating heterogeneous systems. It may also be noted that the text does not discuss numerical methods in any detail; numerical multigroup methods are mentioned but not developed. It may be that individual instructors would wish to supplement this book by some additional material on transport theory or numerical method.

In summary, I recommend this work as a first-rate introduction to nuclear reactor theory. It gives the student an excellent physical understanding of the theory as well as an introduction to many of the most important methods for solving practical problems in reactor design.

* * *

George I. Bell, a theoretician interested in neutron transport theory, is at Los Alamos Scientific Laboratory.

Structural variety in crystals

POLYMORPHISM AND POLYTYPISM IN CRYSTALS. By Ajit Ram Verma and P. Krishna. 341 pp. Wiley, New York, 1966. $12.75

by H. M. Otte

The discovery of polymorphism apparently dates back to 1798 when Kloproth reached the conclusion that the minerals calcite and aragonite have the same chemical composition, $CaCO_3$. This observation was contrary to all the accepted ideas of that time, and was not universally accepted till more wide-spread occurrence of polymorphism was recognized some 25 years later. We now realize that the phenomenon is exhibited by a large number of substances. Knowledge of polytypism, however, is of more recent origin and can be traced to its discovery in silicon carbide around 1912 by Baumhauer, who named the phenomenon "polytypie." Although it has since been observed in other substances such as zinc sulfide and cadmium iodide, silicon carbide remains the one in which it has been investigated most extensively. In spite of its title, the book is primarily about polytypism and in particular about silicon carbide. In fact, chapter 5 is entitled "Silicon Carbide and Other Polytypic Substances." Apart from being, for a long time, the only substance known to be polytypic, silicon carbide has also received considerable attention because of its increasing technical and industrial importance. Its usefulness as an abrasive has long been known, but its importance as a high-temperature semiconductor is only currently being explored.

Polytypism is actually to be considered as a special one-dimensional polymorphism, so that the different polytypic modifications can be regarded as built up of layers of structure stacked parallel to each other at constant intervals along the variable dimension. The unit cell dimensions parallel to these layers are thus the same for all the modifications, but the third dimension, always an integral multiple of the layer spacing, will depend on the stacking sequence. Consequently, different manners of stacking these layers may result in structures having not only different morphologies but even different lattice types and space groups. As a result the possible number of polytypes is almost unlimited, and some 50, with repeat distances ranging from two to an incredibly large 1200 interlayer spacings, are listed by Verma and Krishna for silicon carbide.

The theory of polytypism is discussed in detail (chapter 8) and the book concludes with recent observations on polytypism and the present position (chapter 9). Other chapters in the book deal with the thermodynamic (or phase) aspect and with the structural aspect of polymorphism (chapters 2 and 3); with a description of polytypic structures (chapter 4) and with the structure determination

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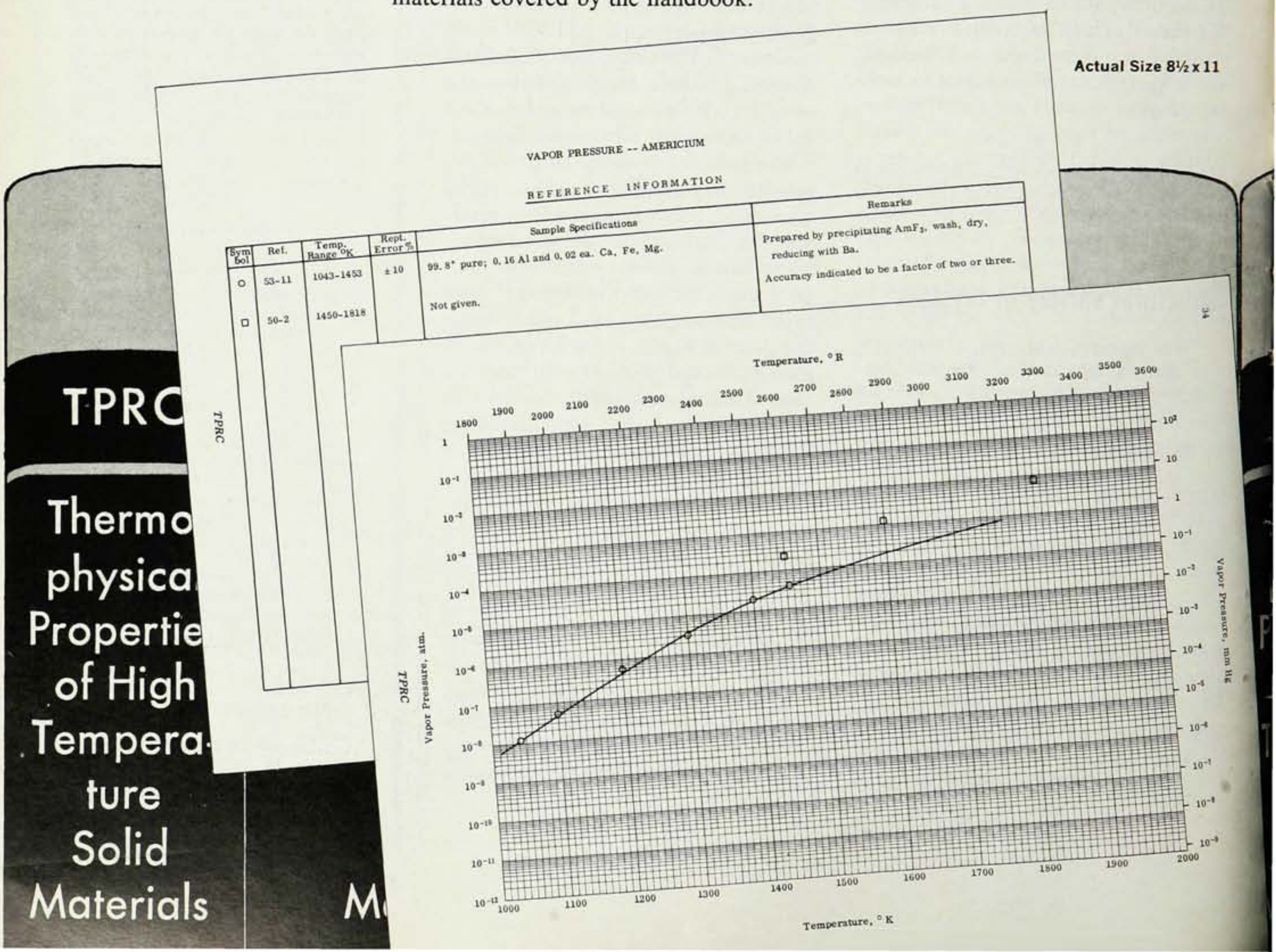

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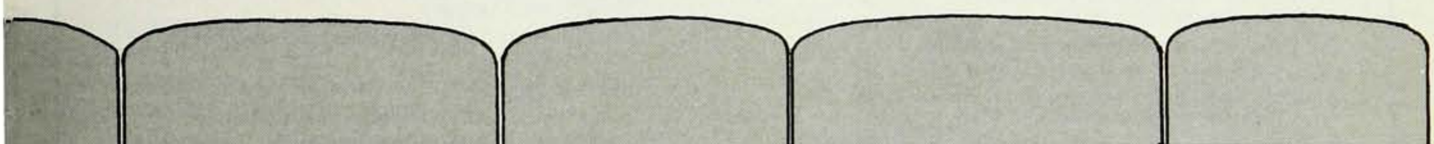

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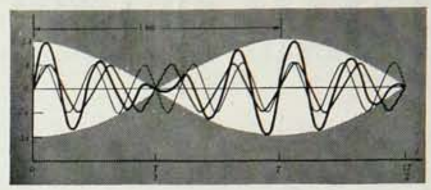

By *Gaylord P. Harnwell*, University of Pennsylvania and *George J. F. Legge*, University of Melbourne

May 1967 / Approx. 608 pp. / $9.95

This textbook is designed for use in a full-year introductory college physics course for students who are non-physics majors. The book introduces the quantitative concepts and procedural definitions of physics as a basis for understanding present descriptions of physical phenomena. Totally modern in approach, it presents classical concepts wherever appropriate.

The authors begin with a summary of the requirements for a suitable description of physical phenomena, and proceed from the intuitive to the quantitative, introducing ideas of space, time and motion, followed by the concepts of mass, force, momentum, and energy. The physical processes of these concepts are formulated in terms of simple symmetries and the conservation laws relating to them. An important aspect of the book is that it approaches each topic from the microscopic to the macroscopic level. This work is unique in that it 1) provides a philosophical approach, describes the discovery of the basic laws of classical physics applicable to the atomic domain, 2) uses the basic atomic concepts and elementary statistics to provide the foundation for a description of the properties of matter in bulk, and 3) extends the account to recent advances in nuclear and high-energy physics.

The authors have included numerous worked examples with answers within each chapter. Also there is a selection of problems; the odd-numbered problems are answered at the end of the book. Answers to the other problems will be available in a separate supplement. Special aids include a bibliography at the end of each chapter and detailed appendices. The book is copiously illustrated with diagrams, photographs, graphs, and tables.

CHAPTER HEADINGS

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of polytypes (chapter 6). There is also a chapter on dislocations and the spiral growth of crystals. On surveying the subject, one is inclined to agree with the authors' conclusion that a very large number of factors influence the phenomenon of polytypism: the temperature and rate of crystallization, the presence of impurities, the screw and edge dislocations created during growth, the thermal vibrations of the structure, and the electron energy-band gaps. The theories so far advanced are all based on one or another of these factors only, and are therefore unable to provide a satisfactory explanation of all the observed facts. The need for a single consistent theory of polytypism embracing all these factors is clearly a desirable objective.

Verma, who is director of the National Physical Laboratory, New Delhi, India, is well known not only for his many scientific contributions using x-ray diffraction and optical techniques to study the defect structure of crystals, but also for his earlier book *Crystal Growth and Dislocations*, published in 1953. Verma was among the first to photograph molecular growth spirals on crystals by phase contrast microscopy. The heights of the steps of growth spirals are intimately related to the structure of the crystal and thus to the magnitude of the Burgers vector of the dislocation that can form in the structure, and its polytypes (if any). Krishna is a lecturer in physics at the Banaras Hindu University, Varanasi, India, where he obtained his PhD; he worked at the Cavendish Laboratory and has done research on the structure of silicon carbide. In fact, the book, which constitutes the first in a new Wiley series, Monographs in Crystallography, edited by M. J. Buerger, is based on his PhD thesis.

There are in the book many illustrations, both line drawings and photographs, all of good quality. The subject index as well as the name index seems quite complete, although Paterson's name, which appears in three places (pages 267, 293 and 330) is each time spelled incorrectly with two t's—perhaps a rather trivial point, since the authors are to be highly commended for writing a very comprehensive and well documented text on the subject of polytypism. Literature on this subject has been scattered among a number of journals in the diverse fields of crystallography, physics, mineralogy, chemistry, geology, metallurgy, etc., each presenting a different aspect of the problem. The authors' aim to present a single collected account of all the different aspects of the problem may be regarded as particularly successful. Stress is placed more on the underlying physical principles involved than on elaborate mathematical treatments. Each aspect of the problem is described from a sufficiently elementary level for it to be intelligible to one comparatively unacquainted with this field. The volume is intended to be completely self-sufficient, and the various developments are effectively presented so as to maintain continuity of thought rather than chronological order. Indeed, the subject matter of the book is such that we may expect it to be the forerunner of polytypes to come!

* * *

H. M. Otte is manager of the Materials Research Laboratory of the Martin Company at Orlando, Fla.

Coulomb excitation and symmetry

COULOMB EXCITATION. By L. C. Biedenharn and P. J. Brussard. 334 pp. Clarendon Press, Oxford, 1965. Paper $6.40

by E. Guth

Coulomb excitation of nuclei is less than fifteen years old. It contributed greatly, and still contributes importantly, to our knowledge of nuclei. Use of the well known electromagnetic interaction avoids the complications of the nuclear-force problem. Thus, nuclear structure can be studied directly, using protons, heavier ions and electrons. The "modern phase" of Coulomb excitation went hand in hand with the development of the unified rotational and vibrational nuclear model by the Copenhagen group. In particular, the collective enhancement of nuclear quadrupole transitions, predicted by the unified model, accounted for the comparatively easy observation of such transitions. Experimentally, it was aided by the then new (1952–53) sodium iodide crystal detectors.

The rapid early development of Coulomb excitation was admirably summarized in the "classic" article in *Rev. Mod. Phys.* by the Copenhagen group. The present very comprehensive book by two experts (L. C. Biedenharn is at Duke University and P. J. Brussard at the University of Utrecht, Holland) is a most worthy successor to that older review and is destined to become a "classic" also. The distinguishing feature of the authors' treatment is the full use of the *symmetry* properties of the Coulomb field. The symmetry groups of the Coulomb problem are the four-dimensional rotation group and the Lorentz group for negative and positive energies, respectively. Such invariance groups are often discussed these days in connection with symmetries of elementary particles.

The book starts with an historical introduction. This is very commendable, as often in physics the historical development is forgotten. Semiclassical and full quantum calculations are presented next. The basis is, wherever possible, the symmetry of the Coulomb field. This symmetry is used to explain the occurrence of the many "exactly soluble" Coulomb-excitation problems. More involved Coulomb processes, like direction-polarization correlation, triple correlations, etc., are thoroughly discussed, followed by multiple Coulomb excitation. The experimental pursuit of the latter was facilitated by the advent of heavy-ion accelerators.

Excitation of high-energy electrons is reviewed next. Finally, there is a short but meaty chapter on nuclear structure in the context of Coulomb excitation. There are many original twists of problems treated before and also many new developments in the book.

The documentation is extensive and authoritative. The reviewer noticed only one small error (on page 312, note 72, the Lorentz group should have been omitted). Although the book is mostly theoretical, comparisons with experiments are made and references to experimental papers are given.

In view of its stress on symmetry, this book should be of great interest