BOOK REVIEWS

The Science of Science. Methods of Interpreting Physical Phenomena. By Russell Fox, Max Garbuny, and Robert Hooke. 243 pp. Walker, New York, 1963. $5.95.
Reviewed by R. B. Lindsay, Brown University.

The enormous growth of all branches of science, which is one of the characteristics of our time, points up the need for continued attention to the public presentation of modern scientific ideas in terms which the intelligent layman can understand. Actually, the many books that have been written to popularize the achievement of twentieth-century physics have been by no means uniformly successful. Many tend to bog down in a mass of factual detail, while others concentrate primarily on elaborate but not too well explained pictures. The authors of the present volume have limited themselves to the attempt to examine with care some aspects of physics which are basic to its existence as a science. Thus, they discuss at length such topics as the nature of experiment and what it means to measure something, the need for precise units for physical quantities, the handling of errors of measurement, the importance of the use of mathematics in physics, etc. The result is a kind of small-scale, pragmatic philosophy of physical science. It does not pretend to go thoroughly into the nature of physical law and theory, but it does give the reader a rather good idea of what the physicist is up against in the laboratory and what he does about it.

One chapter, entitled "Extending the Senses," contains an instructive but at the same time entertaining account of the way in which physical methods and instruments have been able to extend the domain of human sensation to sounds the ear cannot hear and light which the eye cannot see. This provides an appropriate introduction for a survey of atomic and nuclear physics, treated mainly from the standpoint of instrumentation. In order that the reader may not get too exaggerated an impression of the precision of physical measurements the authors have inserted several chapters on the limitations imposed on measurement by "noise" in its various forms. The treatment of fluctuation phenomena is adequate, but probably should have been developed in somewhat greater detail in order to be meaningful to the average reader. Toward the end of the book, indeed, the treatment tends to become a little too sophisticated for the purposes the authors have in mind.

The style of writing throughout is both clear and agreeable. There are a large number of clear diagrams and attractive halftones. The book is pleasant to read and should appeal to a wide range of readers.

Mechanical and Electrical Vibrations. By J. R. Barker. 221 pp. (Methuen, London) Wiley, New York, 1964. $3.50.
Reviewed by C. H. Holbrow, Haverford College.

Vibratory behavior is a phenomenon of great importance to physics. Nearly every physical system is capable of vibration in some sense. The richness and high state of development of branches of mathematics suitable for describing linear systems make available some particularly powerful and useful mathematical tools for physical analysis. One consequence is that systems which are apparently different physically have important underlying features in common. For example the similarity of a simple pendulum and an *LC* circuit is not immediately evident, nor is it clear what a mass bobbing at the end of a spring has in common with a gyrating object.

Dr. Barker has written this book to emphasize the underlying similarity of the different vibratory systems while developing and explaining the mathematics used in their analysis. The subject is developed carefully with numerous examples drawn from a variety of oscillatory systems. After an analysis of simple free vibrations, simple forced vibrations, and damped forced vibrations, he discusses lumped and distributed systems, duality, linearity and nonlinearity, superposition, and the response of a linear system to a general forcing function. All of these topics are discussed with careful reference to physical example.

The latter portions of the book introduce the use of generalized and normal coordinates, generalized forces, and Lagrange's equations for the construction of a general theory of linear vibrating systems. Analysis of linear systems in terms of complex numbers is also developed with particular reference to electrical circuits. There is no attempt to discuss Fourier series or integrals in any detail. This omission is purposeful with the aim of keeping the level of the book suitable for undergraduates.

The book is very well written and for the most part is at a level suitable for undergraduates. It serves admirably to illustrate the underlying similarity of outwardly disparate phenomena and clearly reveals the power and utility of the methods used to analyze such systems. The price of the book is reasonable, and I strongly recommend it for undergraduates studying mechanics beyond the introductory level.

Monte Carlo Methods. By J. M. Hammersley and D. C. Handscomb. 178 pp. (Methuen, London) Wiley, New York, 1964. $4.75.
Reviewed by George Weiss, Rockefeller Institute.

Monte Carlo methods have the apparent attraction of providing results, while requiring a minimum of cerebral effort. It is the moral of this book that careful design of Monte Carlo experiments can pay off, often in orders of magnitude of calculation time saved. Dr. Hammersley, in particular, has made many contributions to Monte Carlo methodology, particularly in the introduction of the technique of antithetic variables, to reduce considerably the variance of estimates.

This monograph, a worthy addition to the Methuen series, gives an outline of various methods for deriving maximum information from Monte Carlo experiments, as well as a catalog of Monte Carlo methods for solving problems which might not seem amenable to probabilistic methods at first glance. Physicists with the inclination to apply Monte Carlo to their particular problems would do well to consider the use of such techniques as importance sampling, antithetic variates, or conditional Monte Carlo, to maximize the efficiency of their calculations. A good short introduction to these methods is to be found in the present volume. Examples of their use are taken from the fields of radiation shielding, polymer physics, and statistical mechanics.

If there is any fault to be found with the book, it is that the authors are occasionally too enthusiastic in appearing to suggest the use of Monte Carlo. For example, it is unlikely that random sampling will be more useful for the calculation of large-scale matrix products than some deterministic method. There are also occasional overhastily written sections, as on page 33, which is almost incomprehensible. Nevertheless, the book is a valuable introduction to an interesting and often quite useful mathematical technique, and can be warmly recommended.

Principles of the Theory of Solids. By J. M. Ziman. 360 pp. Cambridge University Press, London, 1964. $8.50.
Reviewed by Lars C. Luther, University of Copenhagen.

The author of *Electrons and Phonons* offers a demanding and rewarding text for graduate students in physics. Its main purpose is to present ideas on a selection of fundamental topics. Usually it has several ideas on each subject and impresses with the mileage it can get out of a simple idea before going over to the more complicated one. It does not forget to point out where both the simple and the sophisticated ideas will fail. The author draws the line on one side by avoiding bubble diagrams and group theory, on the other by excluding tables of measured quantities and comparisons between theory and experiment. He very deliberately limits the discussion to a few topics: periodicity, phonons, electrons, optical properties, magnetism, and superconductivity, all in perfect crystals. The last restriction is the most serious one. Impurities are only considered in two instances: impurity levels in semiconductors and electron scattering. Imperfections are not considered at all. Thus, regrettably, the text will probably not easily surmount the barrier between the physics and the chemistry departments. The author anticipated criticism on this account and with his superior presentation makes a strong case for the philosophy of preferring to explain some things well rather than mentioning almost everything.

A few words about particulars. The eleven chapters contain 174 simple and helpful diagrams, but no graphs dotted with experimental points or photographs. There are no problems or exercises, but the reader who wants to carry the mathematics along will find things to do. Symbols are consistently used, but unfortunately ν and v, when equipped with subscripts, look very much alike and mean related things. There is an exhaustive index and a list of references for supplementary reading. These references are to recent books and review articles with careful exclusion of original articles as a matter of principle (what principle?).

Physical chemists will find the prerequisites somewhat demanding: Fermi-Dirac notation, time-dependent perturbation theory, scattering (Born approximation and partial-wave analysis), normal modes of the lattice, and, as the author puts it, elementary descriptive facts about solids. Although it is quite reasonable to expect the student to be acquainted with ladder operators, it is unreasonable for the author to presuppose second quantization language, at least more unreasonable than for the reader to expect a text on the theory of solids to develop the ideas of N-representation and creation and destruction operators. This topic does not require much space, and one might save some by eliminating the résumé starting with "it is well known".

Where does the book take the reader from here? Naturally, it aims to show him the ideas behind various experimentally established rules. Also naturally it develops the mathematics of simple, successful theories while emphasizing the vital assumptions. Its real distinction rests on three features. It has an easily appreciated structure; there is no doubt about which chapter deals with what. Secondly, though difficult theory is presented, the mathematics is kept under control and interspersed with pauses for breath while the preliminary result is examined from another angle. A good example is the calculation of electrical conductivity from the Boltzmann equation rather than from kinetic arguments. Although this is much more difficult, the development can be followed without agony and is more rewarding. Again the author's ability to convey the essence is demonstrated in a well-balanced survey of the multitude of attempts to obtain electron wave functions for solids. Thirdly, the book has the advantage of being up to date; it discusses BCS theory and the de Haas–van Alphen effect.

Perhaps one can give an idea of the range covered within the selected subjects by mentioning a few topics which are parenthetically discussed: cohesion, phonon-phonon interaction, umklapp processes in thermal and electrical conductivity, the two-dimensional Ising lattice. The discussion of magnetic properties is essentially restricted to ferro- and antiferromagnetism considered in the light of the two approaches: the Ising model and spin waves.

Strong, Electromagnetic, and Weak Interactions. Summer School Proc. (Erice, Sicily, 1963). A. Zichichi, ed. 248 pp. Benjamin, New York, 1964. Cloth $9.00; paper $4.95.
Reviewed by J. E. Mansfield, Harvard University.

This is a rather short set of notes from the Summer School "Ettore Majorana" of 1963. J. S. Bell of CERN provides an introduction to the elements of S-matrix and field theory, expanded and revised after the other lectures were completed; this no doubt helps, for by then it is clear what needs introducing.

Regge's twenty-page article on nonrelativistic potential scattering is good