Books

Mathematical Foundations of Quantum Mechanics (Number 2 in the Series Investigations in Physics). By John von Neumann. 445 pp. Princeton University Press, Princeton, N. J., 1955. Paperbound $6.00. *Reviewed by M. E. Rose, Oak Ridge National Laboratory.*

After the rapid development of quantum mechanics in the twenties, the appearance of the original German edition of von Neumann's work was very welcome indeed. To quote the author: the purpose is to present the new quantum mechanics in a unified and mathematically rigorous representation. How well he succeeded is a familiar story to most physicists and, presumably, to a fair number of mathematicians. After almost a quarter of a century this book is still a valuable addition to any library. There are few references in which quantum statistics, including the concept of the density matrix and a discussion of the theory of measurement, is treated in as masterful a manner.

There seems to be little doubt that in this country insufficient attention has been given to a number of works of major importance which have not appeared in English. While this result of the post-war, westward shift of the center of gravity of physics is understandable, it is also regrettable. However, the most practical remedy is certainly to be found in efforts like that of the translator. He is to be congratulated on an excellent piece of work. As R. T. Beyer remarks in the translator's preface, "the manuscript has been carefully revised by the author so that the ideas expressed in this volume are his rather than those of the translator."

The Atom (Fourth Revised Edition). By Sir George Thomson. 204 pp. Oxford University Press, New York, 1955. $1.00. *Reviewed by Bernard T. Feld, Massachusetts Institute of Technology.*

In Britain (and on the Continent) people like to read and, furthermore, they are not averse to reading about esoteric or technical subjects. In response to this demand, there is available to the general public a large variety of popular tracts on all sorts of topics of "intellectual" interest. These books are, in general, well printed, well bound, pocket-sized, and cheap. What is more, many are written by outstanding authorities who not only know their subject, but also write well, and who devote great efforts to the problems of simplification and popularization of technical matters.

The book here under review is an excellent example of the genre. It was written for the Home University Library of Modern Knowledge series, first published in 1930, and has been thrice revised and extended. The author is emeritus professor of physics at the University of London and recipient, together with C. J. Davisson, of the 1937 Nobel Prize in physics for "experimental discovery of the diffraction of electrons by crystals".

The main part of the book deals, in clear, concise, and nontechnical language, with the experimental basis for the presently accepted wave-mechanical model of atomic structure. The approach is essentially historical, and the author manages to convey much of the excitement of fresh discovery through this approach. Difficult physical concepts are not glossed over, but usually explained in terms of apt analogies (e.g., the very nice discussion of the low temperature specific heat anomaly in terms of the effect of the average income of a community on the relative rates of purchase of Fords and Rolls Royces).

The parts dealing with nuclear structure and radioactivity are somewhat less satisfying, in part because the author tries too hard to be up-to-date. Also, it is clear that the author is less steeped in this subject matter. However, there is a short section on the political and social implications of nuclear energy which is a model of logical, sober, and enlightened scientific humanism.

The books ends with a brief exploration of some possible implications of modern physical theories on the old philosophical problem of "determinism *vs* free will". This attempt has the virtue over most others with which this reviewer is familiar that the problem is defined clearly and the arguments can be followed even by the nonprofessional philosopher.

This small volume is strongly recommended to interested laymen, teachers, physicists, and science writers as collateral reading for a course in atomic physics, as a source of stimulation, or just for relaxation.

Quantum Mechanics. By F. Mandl. 233 pp. (Butterworths, England) Academic Press Inc., New York, 1954. $5.80. *Reviewed by Philip M. Morse, Massachusetts Institute of Technology.*

This volume contains, in somewhat compressed form, a carefully written basis for an introductory course in quantum mechanics. It does not delve deeply into questions of fundamental philosophy or mathematical rigor nor does it discuss the calculation of specific atomic or nuclear problems and compare results with experiment. Rather it develops, carefully and logically, the main concepts and mathematical techniques of nonrelativistic quantum mechanics, from the point of view first expounded by von Neumann and Dirac.

There are nine chapters; the first on the mathematical properties of Hilbert space, and its relationship to the eigenvalue problems of physics, together with definitions of the delta function, of Fourier transforms and other parts of mathematical machinery needed later. The second chapter introduces wave mechanics and the third chapter takes up simple examples of energy eigenfunctions, ending with the angular functions for a spherically symmetric potential and the properties of the angular momentum operator. This last material is used, in the fourth chapter, as an example to illustrate the discussion of general quantum principles, of operators, of the uncertainty principle and commutability.

The fifth chapter deals with the matrix formulation of quantum mechanics and the sixth applies this to a general discussion of the angular momentum operators for systems of particles. Here the Pauli spin operator is introduced, several examples of the addition of angular momenta are worked out and the Pauli principle for identical particles is discussed.

The seventh chapter gives an elementary discussion of perturbation theory and the eighth chapter takes up collision problems, introducing the integral equation formulation, the Born approximation and the time-dependent approach. The last chapter is an introduction to group theoretical ideas and their application to spin operators and to the formulation of selection rules. At the end of each chapter are a dozen or so problems, with answers discussed at the back of the book. There are an appendix listing vector formulas, a short bibliography, and a $2\frac{1}{2}$-page index.

The style is easy and understandable. Conceptual and mathematical difficulties are pointed out and, where they are not discussed thoroughly, reference is made to more complete treatments. Although many subjects, not included here, should be in an introductory course in quantum mechanics, this text can provide the appropriate order and the basic framework for such a course. This reviewer considers it the best of the recent batch.

The Elements of Probability Theory and Some of its Applications. By Harald Cramér. 281 pp. (Almqvist & Wiksell, Sweden) John Wiley & Sons, New York, 1955. $7.00. *Reviewed by Harold W. Kuhn, Bryn Mawr College.*

This book is an introduction to probability theory; it has been planned with great care for the reader who has some working knowledge of analytic geometry, calculus, and determinants, but who is not prepared for more advanced treatises such as Feller's *Probability Theory* (Vol. I, John Wiley & Sons, 1950) or Cramér's own *Mathematical Methods of Statistics* (Princeton University Press, 1946). The treatment emphasizes the statistical applications without losing sight of the fact that the mathematics of statistics is but a part of the mathematical theory of probability.

The volume is divided into three parts: foundations; random variables and probability distributions; applications. Although this arrangement is reminiscent of the author's *Mathematical Methods,* the content differs both in level and in subject matter. The first part traces the historical development of the concept of probability and exposes in a lucid style the author's view that it is "a mathematical model for the description and interpretation of phenomena showing statistical regularity". Probabilities are only defined for events attached to some random experiment which can be repeated several times under uniform conditions. The remainder of this section is devoted to deriving the elementary rules for calculating probabilities and some simple applications.

The second part provides the bridge between probability theory and statistics. It treats the basic properties of random variables and discusses in some detail the more common distributions. In proving various theorems (for example, the central limit theorem) the author settles for a proof of a special case and states more general results with appropriate references to the literature.

The third part of the book deals with statistical practice. Although the space is limited (107 pages), the topics chosen for treatment are handled with great clarity. The reviewer found the last chapter, which discusses the theory of errors, regression problems, analysis of variance, sampling, and quality control, to be particularly distinguished.

Numerous problems, appended to each chapter, enhance the value of the book as a textbook, as do the well-chosen historical references. Tables of the χ^2, normal, t and F distributions are included.

Proceedings of the Northwestern University Conference on the Training of College Physics Laboratory Assistants. Edited by C. J. Overbeck. 168 pages. Northwestern University, Evanston, Ill. 1954. Paperbound. *Reviewed by E. C. Watson, California Institute of Technology.*

The problem of improving the quality of laboratory instruction in the general physics courses is engaging the attention of most college physics departments at the present time. The problem is most acute in the larger institutions in which hundreds of students must be accommodated in the general laboratory and graduate assistants must be used.

A nationwide conference to study this problem, planned and organized by S. C. Brown of the Massachusetts Institute of Technology, C. J. Overbeck of Northwestern University, and C. N. Wall of the University of Minnesota, and supported by a grant from the National Science Foundation, was held at Northwestern University on June 25 and 26, 1954. It was attended by more than forty of the physicists who have the responsibility for directing the general physics laboratory work at their respective institutions. The publication under review is a full and carefully edited account of this conference.

While the whole report should be read if full justice is done to the conference, the main results were summarized by a Committee on Conclusions under the following headings: