Book Review

Introduction to Nuclear Theory. By I. E. McCarthy, John Wiley and Sons, New York (1968). 534 pp. $13.95.

The character of this book, and the perspective it provides of nuclear physics, is best intimated by the author's description of himself in the preface as "a person interested in the use of nuclear reactions in order to understand nuclear structure." For this is indeed the emphasis in the book—formal reaction theory applied to the interpretation of measurements in terms of nuclear structure. Consequently, great attention is paid to the rigor of the logic, and in this context such attention implies heavy going. It is not a book to be read casually for an introductory understanding of nuclear theory. To be read profitably it needs to be studied—at least that was my experience.

Concentration is upon the low energy region and the phenomonology of nuclear models invented to describe it. Little or no attention is paid to mesons, leptons, and photons; but several nuclear-force potential models are examined in some detail. The models for characterizing many-nucleon nuclei—the shell model, collective model, and cluster model—are surveyed with some attention paid to the mathematical description of states and details of how to compute certain quantities of theoretical importance. In these areas; new ideas, sophisticated analytical techniques, and quantitative assessment of approximations are often introduced and discussed practically simultaneously. The experienced reader may find this aspect of the book quite useful as a source, but the beginner is apt to find it confusing.

The coupling of nucleons and nuclei to the electromagnetic and leptonic fields is largely ignored—presumably not by oversight but deliberately, The absence of discussion of electron scattering, coulomb excitation, radiative transitions, cascade gamma angular correlations, and beta decay is consistent with the author's stated purpose to concentrate on nuclear reactions exclusively. Since a good deal of the illumination of nuclear structure is provided by these interactions, it seems to me that the work is somewhat narrowly conceived as a text on nuclear theory. Furthermore, though the subject matter treated is dealt with thoroughly and often in considerable detail, the presentation moves quickly to formal and sophisticated analysis; so that it is difficult for me to consider it as truly introductory.

The treatment of reaction theory in general, and the applications to interpretation of nuclear reactions in particular, is very good. The subject is developed carefully and lucidly from first principles, although considerable familiarity with and understanding of the formalism of quantum mechanics is presumed. Enough detail is provided for the uninitiated, though motivated and properly equiped, reader to learn a good deal of formal reaction theory without undue effort or recourse to other sources. Nearly three quarters of the text is devoted to this subject. Of course, not all of the applications are germane to reactor physics, but the nuclear engineer who feels the need for more than a qualitative understanding of nuclear reactions may well find this work helpful. The various, formally rigorous, perspectives on the subject are developed, interrelated, and explored for their implications. At the same time, considerable attention is paid to approximation schemes for the extraction of some of the conventional interpolation formulas for practical application.

In summary, this book provides brief, but informative, reviews of phenomenological nuclear forces and of the standard models for correlating data on nuclear structure. But mainly (at least for the reactor physicist) it provides a detailed and readable development of formal reaction theory. It is not oriented to the needs and interests of the applied scientists—except perhaps incidentally with respect to the item just mentioned. It is not a wide-ranging book on nuclear physics—too many topics (e.g., fission, fusion, beta-decay, electromagnetic intereactions, to name a few) are either slighted or completely ignored. It is not a book to be read casually for the acquisition of knowledge, but it can be profitably studied for an enhancement of understanding.

Richard K. Osborn

The University of Michigan
Ann Arbor, Michigan

March 18, 1969

About the Reviewer: Professor Osborn, of the Department of Nuclear Engineering, University of Michigan, has been a welcome contributor to these columns previously. Following graduate studies at Michigan State and Case Institute of Technology, Dr. Osborn was associated with the Oak Ridge National Laboratory for six years before assuming his present position. His interests are in nuclear and reactor physics and in plasma dynamics.