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Book Reviews

Internal Conversion Processes. Edited by Joseph H. Hamilton. Academic Press (1966). 669 pp. $22.50.

Internal conversion has had a long, and sometimes important, part to play in the development of the understanding of nuclear structure. Furthermore, a knowledge of internal conversion coefficients is necessary in many current applications of nuclear science.

The appearance in the mid-fifties of Rose's and of Sliv and Band's comprehensive tabulations of conversion coefficients for the K and L shells ended an era in which the multipolarities of transitions had to be derived by comparison with more approximate calculations, or with the semi-empirical K/L and L-subshell ratios of Goldhaber and Sunyar, Mihelich, and others. Assiduous experimenters, however, have continued to improve techniques, until the precision of many current experiments is comparable with, or exceeds, the accuracy of the great tabulations. The important new area of angular correlations involving conversion electrons has been studied in some detail in the last few years. Finally, the hope that new kinds of information could be derived from the study of transitions in which some of the conversion is due to those parts of the electron wave functions which penetrate inside the nucleus, and thus where the conversion coefficient is nuclear-structure dependent (Church-Weneser effect), has been at least partially fulfilled.

It was primarily for the discussion of these last three topics that an international conference, with J. H. Hamilton as chairman, was held at Vanderbilt University in May of 1965. The proceedings of the conference provide the bulk of the present book, which also contains some specially written introductory material.

Rose's introductory chapter is a very useful discussion of the theory of internal conversion. The reviews of Stelson (conversion coefficients from Coulomb excitation and lifetime measurements) and Geiger (conversion of high-multipole-order transitions) are especially good. A rather complete account of current work on angular correlations is contained in the four invited papers of Gerholm and Pettersson, Thun and collaborators, Yamazaki, and Deutch and Hornshøj. Interesting work on the angular distribution of conversion electrons emitted by an oriented sample is reported by Stone, Frankel, and Shirley.

Ways to improve the luminosity of the classic double-focussing spectrometer are detailed by Bergkvist, and a new kind of high-resolution spectrometer is described by Daniel and collaborators. Many important uses of semiconductor spectrometers in conversion and gamma-ray work are reviewed by Hollander.

The beginnings of new calculations, in some ways improving on, and in some ways extending, the classic ones, are briefly reported by Seltzer and Hager, and by Bhalla. It may be expected that, in the years to come, much more emphasis will be placed on the study of conversion electrons emitted during nuclear reactions; some examples are included by Sakai et al. (p,2n reactions) and by a Berkeley group (fission fragments). Nuclear-structure effects in conversion are discussed by Herrlander and Ewan, by Hager and Seltzer, and in several of the angular-correlation papers.

While comparison with the classic tabulations is usually sufficient to determine a multipolarity (if it is unique) it is of interest in some cases to determine multipole mixing ratios with a high degree of accuracy. The difficulties involved are reviewed by Novakov. Some evidence that the classic tabulations are not in accord with experiment for L-shell conversion of low-energy $E2$ transitions is presented by Mladjenovic et al. (It has since been reported that the discrepancy is about five percent.)

The proceedings of the conference are lucidly summarized by Rasmussen. The volume closes with 65 pages of tables and graphs; all of them will be useful to workers in the field, and the tables of conversion matrix elements and particle parameters are a new and important supplement to those previously available.

The volume is more smoothly edited and conveniently arranged than most conference proceedings. Its high price makes one reluctant to recommend it for most personal libraries; no student of internal conversion can consider himself up to date, however, if he is not acquainted, in one way or another, with most of the contents.

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About the reviewer: Guy Emery studied at Bowdoin and at Harvard, where his thesis concerned internal and external conversion studies of the thorium active deposit. He has been a member of the nuclear spectroscopy group at Brookhaven National Laboratory, and in 1966 joined the faculty of Indiana University. His recent work has included collaboration on a study of chemical effects in internal conversion.

Irradiation Damage to Solids. By B. T. Kelly. Pergamon Press (1966). 232 pp. $4.50.

The field of research covered by the title of this book is too large to permit more than a brief introduction to be encompassed in a book of this size (232 pages). The author recognizes this fact and points out that many currently important areas of research have necessarily been omitted or treated only sketchily. Nonetheless, the general approach taken by the author has considerable merit. Rather than trying to review the experimental information in the field (already well done by Billington and Crawford[1], which, however, needs updating), he has tried to present the ideas behind present-day research in radiation damage, and to expose some of the controversies and weak points in the theory. Quite a bit of experimental information is included to emphasize or illustrate various points. The initial impression of the book is that a really large number of areas of research are discussed with quite a few references, that considerable care has been taken to give credit to the original investigations in each case, and that a respectable percentage of the physical concepts are given precise formulation, following the treatment of the original papers.

However, in the opinion of the reviewer, the book, upon closer inspection, does not live up to this promise. It is not clear for what audience the presentation is designed. It is far too detailed to serve as an introduction to the field for a general reader (as, for example, the recent book by Chadderton[2]), yet far too incomplete to serve as a reference book for workers in the field. If regarded as a possible textbook, it would have to be for students at the advanced undergraduate or graduate level because of the nature of the theoretical material included. However, it is as regarded from the pedagogical viewpoint that the book shows its greatest failings. The author approaches each topic through a few general statements and immediately launches into an outline of a detailed theory, following some original article. The treatment is such that in most cases there is not enough explanatory material nor enough precise definitions to permit a student to master the subject. This is in contrast to the recent (1965) monograph by G. Leibfried[3] (consistently misspelled in this book as Liebfried) which is clearly and well designed for graduate students.

To this the reviewer must add another and perhaps more severe criticism. It does not seem that the author has sufficiently digested the material (admittedly a vast amount) which he has tried to cover. In many important instances the basic concepts are presented in a way which is misleading or even incorrect. As an example, in discussing dimensional changes in crystals brought about by introduction of point defects (p. 153), the author states that the simultaneous creation of a vacant lattice site and an interstitial atom in the crystal, to a first approximation, increases the volume of the solid by one atomic volume; the creation of an interstitial atom alone, to first order, does not produce any volume increase; the creation of a single vacant lattice site, to first order, increases the volume of the solid by one atomic volume. By "first order" in this case the author makes clear that he means "neglecting lattice relaxation." These mistakes occur so often that the text cannot be regarded as reliable.

In spite of this shortcoming, the book could serve a useful purpose, because of the references accompanying each topic, which would permit the reader to fill in the gaps and correct the errors. However, the author has slanted his references toward the early publications in each area, so that the book cannot serve as a guide to current research. For example, neither of the recent books by Leibfried[3] and Chadderton[2] is referenced. As another example, the brief discussion of conductivity and color centers in ionic crystals has only five references. Four of these are to research papers dated 1953, 1950, 1955, 1957; one reference is to a review article which appeared in 1952.

All in all, the reviewer must conclude that this book provides neither a good review nor a good textbook, both of which are needed (in English!) at the present time in the field of radiation damage.

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March 28, 1967

About the Reviewer: D. K. Holmes is a theoretical physicist in the Solid State Division of the Oak Ridge National Laboratory. At Oak Ridge since 1949, he has been active in reactor projects and nuclear physics as well as his specialty, which is radiation damage in solids. He is a coauthor with R. V. Meghreblian of the text Reactor Analysis *(McGraw-Hill, 1960).*

[1]D. S. BILLINGTON and J. H. CRAWFORD, Jr., *Radiation Damage in Solids*, Princeton University Press (1961).

[2]LEWIS T. CHADDERTON, *Radiation Damage in Crystals*, Methuen and Co. Ltd., London (1965).

[3]G. LEIBFRIED, *Bestrahlungseffekte in Festkörpern*, B. G. TEUBNER Verlagsgesellschaft (1965).

Introduction to Nuclear Physics. By Harald Enge. Addison-Wesley Publishing Company, Inc., Reading, Mass. (1966). 582 pp. $12.75.

In this age of proliferating textbooks and publishers of textbooks it is a real pleasure to read an outstanding new book. It is probable that Professor Enge's *Introduction to Nuclear Physics* will become a new standard.

This book is intended for the advanced undergraduate or beginning graduate student of nuclear engineering or physics. It will also occupy an important position as a general reference, and is well organized for both purposes.

The plan used in most of the chapters is the description of recent examples of important experiments, followed by theoretical discussion. This is a good choice, partly because it is no longer feasible to write a nuclear physics text from an historical viewpoint. At the same time, the nature (or, if you prefer, the temporary lack of theoretical unity) of nuclear physics precludes the use of a purely deductive approach in an introductory book. Ample references permit both the antiquarian and the deductive theorist to pursue his hobby.

Encyclopedic introductory material has been kept to a minimum. The reader is soon at work on important problems (e.g., deuteron structure and partial wave scattering). The treatment of the shell model is good, and this reviewer was transported to his first American Physical Society meeting in January 1950, where Maria Mayer, cigarette holder in hand, lectured on the strong spin-orbit coupling.

The treatment of the collective model is too brief. However, it is followed by thorough and well-written treatments of the classical topics of stopping power, detection, radioactivity, gamma transitions, internal conversion, alpha and beta decay, accelerators, and particle sources. The next chapter, "Nuclear Reactions," is particularly good, containing treatments of charged-particle-reaction spectroscopy, neutron spectroscopy, compound-nucleus theory, resonance reactions, the optical model, stripping reactions, Coulomb excitation, and photonuclear disintegrations.

The short chapter on nuclear energy is a marvel of economy. A little more detail might have prevented confusion about the role of delayed neutrons. One is left with an estimate of exponential period for a thermal reactor that is computed without delayed neutrons, closing with the vague observation that: "When k is made so small that the