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Book Reviews

Beta Decay. By C. S. Wu and S. A. Moszkowski. Interscience Publishers, John Wiley & Sons, New York-London-Sydney (1966). 394 pp. $16.00.

In 1956 one of the most profound revolutions in physics took place, the downfall of parity. It transformed the somewhat static area of β-decay into a most exciting one with many connections to the whole of elementary particle physics. The present book, whose authors themselves have made important contributions to the field, is intended to give a coherent account of the weak interactions, that is, the leptonic decay of nuclei and of other particles. In this they succeed admirably. The treatment is neither encyclopedic nor elementary. The prerequisites are a knowledge of quantum mechanics and a familiarity with at least the terminology of nuclear and particle physics, such as Feynman diagrams, isobaric spin, and strangeness. The Dirac equation and the various symmetry operations are explained in appendixes, but it is perhaps too much to ask that this short introduction should be sufficient as the sole source of information. With the necessary background, the book offers easy and exciting reading. It avoids tedious calculations and technical details of experimental arrangements. The formulas for allowed transitions are derived in full in the appendixes. Those for forbidden transitions are only quoted, as are detailed nuclear structure considerations. However, throughout the book, physical arguments are given to provide an understanding of the results.

The arrangement of the material is roughly in historical order. After an introduction which sketches the development of the field, the classical theory of β-decay is given that is still valid as long as one does not look for pseudoscalar quantities, and which permits the classification of β-decays. Then comes a thorough discussion of the experiments on parity violation and of their consequences for theory. Here, as everywhere else, very careful comparisons between experiment and theory are given, and it is always clearly stated how far and to what extent the facts confirm, suggest, or deny speculative inferences. After a discussion of related processes and other leptonic decays, the last chapter deals with recent developments. The authors state in their preface, "This chapter was written with great emotion and enthusiasm." It gives a very readable description of the concept of a universal Fermi interaction, the theory of conserved vector current, the question of an intermediate boson, and the discovery of two kinds of neutrinos (μ and e).

This book is written by physicists for physicists, and not for nuclear engineers. It conveys everywhere the excitement of discovery. There is an excellent list of references, but the proofreading could have been done more carefully.

After a tortuous path with many false starts, all fully described, the field of weak interactions has reached a degree of maturity that sets it apart from the other branches of elementary particle physics. There are good reasons why the main features, two component massless neutrinos, lepton conservation, and universal Fermi interaction, will have long range validity. Thus the book will not soon be out of date. Certainly there are new and unexpected discoveries to come, but the reader of this volume will be well prepared for them.

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About the Reviewer: Lothar Nordheim is a Senior Research Advisor at General Atomic where his work covers a broad spectrum in theoretical physics, including nuclear and reactor physics. Among his contributions was the first extensive systematics of β-decays on the basis of the nuclear shell model, in part in collaboration with Maria Mayer and Steven Moszkowski, one of the present authors. He was educated in Goettingen, Germany, taught at Purdue and at Duke University, and spent several years at Oak Ridge and at Los Alamos. Dr. Nordheim is a Fellow of the American Nuclear and of the American Physical Societies and is a member of the Editorial Advisory Committee of Nuclear Science and Engineering.

Reactor Physics in the Resonance and Thermal Regions. Edited by A. J. Goodjohn and G. C. Pomraning. Cloth bound. The MIT Press, Cambridge, Mass. (1966). Vol. I, 421 pp. Vol. II, 452 pp. $15.00.

This two-volume set contains the formal papers presented at the National Topical Meeting sponsored by the San Diego Section of the American Nuclear Society on February 7-9, 1966. Volume I contains the papers dealing with neutron thermalization, while Volume II presents those dealing with resonance absorption. An addendum, which reports discussions at the meetings, has been issued separately as BNL-50004 (C-48) and is not part of the set.

Volume I contains papers dealing with the theoretical and experimental aspects of neutron thermalization. Although the theoretical papers are far more numerous than the experimental, many of the theoretical results are compared at great length with experiments.

The experimental papers by Brugger and by Beyster and his co-workers are very interesting. Brugger discusses the possibilities of extracting useful information about the physical properties of a sample from scattering law data for solids, liquids, and gases. Beyster is concerned with integral neutron thermalization measurements, and, in particular, measurements of neutron spectra, and angular and total neutron cross sections. In addition, future problems which seem of considerable interest are discussed.

A paper by Young describes the construction of lattice dynamical models for solid moderators from which accurate scattering cross sections may be obtained. The moderators Be, C, and BeO are considered in the incoherent approximation. Similarly, Koppel analyzes hydrogenous moderators of great interest in reactor design, and compares his theoretical results with numerous experiments. Novel approaches to understanding the process of self-diffusion and incoherent scattering of neutrons in liquids are given by Rahman and by Ardente et al.

Daitch describes the thermalization studies being carried out at RPI, and Corngold considers the eigenvalue problem associated with interpretation of pulsed-neutron experiments. Corngold emphasizes that the difficulties in calculation of these eigenvalues are primarily due to choice of an adequate model for description of the scattering process.

A very good review of transport methods for calculation of spatially dependent thermal spectra is given by Pomraning. In addition to presenting a rather complete description of the various methods for treating the lattice cell problem, he also lists an extensive bibliography of 128 references. Francis discusses variational methods for determining space-dependent neutron spectra and offers several comments on promising new applications and on improvements of the general technique.

The power of the Monte Carlo method for dealing with thermalization problems in complicated geometry is exemplified in the papers by Nakache and Kellman and by Gelbard. Gelbard points out that as computers become faster the Monte Carlo technique should be more widely used to complement the deterministic methods.

Multigroup collision-probability methods for treating fuel-rod clusters are described by Jonsson and Pekarek, while Robinson and Ferziger use Cases's singular integral-equation method and the heavy-gas scattering model to calculate energy-dependent disadvantage factors.

The secondary scattering model of Cadilhac is used in papers by Cadilhac and his collaborators to calculate spectra in thermal reactors, and by Haubert and Meyvaert to treat heterogeneous systems using collision-probability methods. The attractiveness of using simple moderator models is in the retention of some of the physical properties of the moderator as well as greatly reduced computer running times.

Simple moderator scattering models are also used by Hembd (Horowitz generalized heavy gas) in determining the neutron spectrum by flux synthesis and by Kind and Rossi (heavy-gas model) in dealing with irradiated heavy-water lattices.

Volume II contains 17 papers dealing with the subject of resonance absorption. Of these, 6 are concerned with the nuclear cross sections, 3 with measurements of resonance integrals, and 8 with the calculation of the resonance integrals or resonance capture in reactors.

In the cross-section category, a paper by Garrison discusses the calculation of two-level interference effects. A paper by Harvey discusses the measurement of neutron total cross sections in the resonance energy region and the analysis of the data to obtain the total, neutron, and gamma widths. The following paper by Haddad et al. discusses capture cross-section measurements and resonance parameters. For the heavy elements, Smith presents a review of information of the resonance properties of the main fertile and fissionable nuclei, while Brooks discusses measurement of alpha and eta in the intermediate-energy range. A paper by Moore and Simpson is addressed to the problem of the cross sections of the fissile nuclei in the unresolved energy range.

Hellstrand's paper on measurement of resonance integrals describes briefly the methods most commonly used for resonance integral measurements and discusses some of the particular problems that have to be overcome in high accuracy measurements. A paper by LeSage and Sher describes the measurement of infinite-dilution capture resonance integrals using Moxon-Rae counter to detect the prompt capture gamma rays. A survey of measured capture and fission integrals of fissile materials is presented in the paper by Feiner and Esch.

Methods available for calculation of resonance capture in reactors are discussed in three papers. Goldstein describes the intermediate resonance method, while the paper by the Adlers describes the calculation of the energy and spatial dependence of resonance absorption in fissile materials, and finally, the paper by Levine discusses Monte Carlo methods in resonance absorption.

Results obtained in applying available methods to the problem of calculating resonance capture in actual lattices are discussed in the paper by Askew. Resonance capture calculations for gas-cooled reactors are discussed by Tyror et al., while resonance absorption in heavy-water lattices at Ispra is described in a paper by Amyot et al.

Finally, there are two papers on differential effects in resonance absorption. One by Hwang discusses the effect of resonance interference on Doppler calculations, and Greebler and Pflasterer describe Doppler and sodium-void reactivity effects in a fast reactor.

The present state of resonance absorption information as presented here might well be summarized by a quotation from Hellstrand's paper, "Today, the advanced theory of resonance absorption and the availability of large computing machines make it possible to calculate effective resonance integrals with few approximations, even for complicated geometry. However, the calculations rely on experimentally determined resonance parameters and cross section curves, and the uncertainities in these limit the accuracy attainable in the calculation. The directly measured integrals, therefore, still serve a very useful purpose as checkpoints of normalization for the calculation."

In summary, the two volumes provide a fairly complete and current source of information on neutron thermalization and resonance capture. The papers, in general, are of high caliber and contain sizeable bibliographies which make the set a required addition to library shelves and also to the personal collections of reactor physicists interested in these areas.

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About the Reviewers: David Sargis has been a staff member of the Reactor Physics Division, Argonne National Laboratory, since May 1965. His undergraduate work was done at Purdue and he received a PhD in nuclear engineering from the University of California at Berkeley in 1965. His thesis research was in space-dependent neutron thermalization. His present interests are in neutron transport theory, error estimating techniques, and multilevel cross-section analysis.

Paul F. Gast is presently a member of the Liquid-Metal Fast-Breeder Reactor Program Office. Previously, begin-

ning in 1964, he was on the Argonne National Laboratory staff. Prior to ANL, he served in various positions at Hanford dating back to Manhattan Project days. His PhD degree (physics) is from the University of Washington, Seattle, in 1941. He is a Fellow of the American Physical Society and ANS, a member of the Editorial Advisory Committee of Nuclear Science and Engineering, *and a member of the ANS Board of Directors.*

Nuclear Materials Management. Proceedings of Symposium, August 20 - September 3, 1965, Vienna, International Atomic Energy Agency (1966). 878 pp. $18.00.

The management of radioactive materials used as a source of energy for peaceful application in power generation and research has acquired added significance with increased usage and distribution of these materials. Strict control is required not only because of financial motivation, but also as a means of safeguarding humanity from the devastation and suffering that could emanate from the indiscriminate and unauthorized use of such materials. The time appeared appropriate to exchange the vast store of knowledge and experience which has been amassed under various conditions and disciplines involved in nuclear material control. This Symposium served that purpose.

Nuclear Materials Management - Proceedings of the Symposium held by the IAEA at Vienna, August 30 - September 3, 1965, and published by the IAEA in 1966, provides a composite of domestic and international methods and techniques for achieving accurate and effective control over nuclear materials possessing high intrinsic and strategic importance. The subject matter, contained in 58 papers presented at the Symposium, is predominantly by US authors, but includes authors from nine other countries. The papers have been presented in their entirety with minor editing and have retained the essential expressions and style of each author. They have been compiled according to suitable and related categories corresponding to the format of the sessions, i.e., Material Control Systems; Recording, Reporting and Generation of Quantitative Data; Evaluation of Measurement Methods and Nuclear Safety and Criticality Control; Economic Considerations and Government Activities; Chemical and Isotopic Analysis; Burn-up and Production. Each paper is printed in the language of the author with an abstract in English, French, Russian, and Spanish, as applicable, with additional enlightening discussions through question-and-answer sessions which followed most presentations. The majority of papers are profusely illustrated with drawings, schematic diagrams, and, where applicable, documentary forms such as transfer receipt and shipment, internal process flow, inventory, laboratory data, and other forms that represent what can be described as typical documentary requirements for adequate control. Equally important, many of the papers provide added reality in describing accountability control by inserting reproductions of actual processing data recorded during apparent routine operating conditions. Many papers contain a listing of pertinent reference materials which offer the reader an opportunity of delving more fully into a particular facet of interest.

The papers represent the culmination of many years of experience in arriving at the most proficient techniques of handling nuclear materials and maintaining a systematic approach toward accounting for these materials and determining the reliability of supporting data by evaluations using statistical methods. The lay individual with only general industrial or professional experience will find the rationale and background material contained in the introductory remarks of each paper of sufficient latitude and concise depth to permit understanding and appreciation of the problems facing industry and government in protecting and controlling nuclear materials. The papers show how the experience obtained in the control of large-quantity, lower-value materials, as well as those of high intrinsic and monetary value, has been adapted to nuclear materials possessing not only these qualities but also radioactive properties requiring remote-handling devices and other special techniques. Those familiar with material control and particularly those specializing in certain portions of the industrial processing complex which extends from mining raw ore through fuel fabrication, reactor irradiation, and reprocessing recovery will find the details appealing, since the interaction of many techniques of accounting and measurement are applicable over a broad area of interest.

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About the Reviewer: Nicholas Ovuka, a member of the Division of Nuclear Materials Management at Headquarters, US Atomic Energy Commission, is continuing a career in nuclear matters dating back to Manhattan District days with early service at Oak Ridge, Hanford, and Savannah River. Mr. Ovuka received his academic training, both undergraduate and graduate, in chemical engineering, at the University of Pittsburgh and has held responsible positions in nuclear fuel fabrication, chemical reprocessing, and materials control with both the government and private industry.