

On the whole, this reviewer found it an interesting book but feels that the "pedestrian" would have to be reasonably fit to appreciate it.

Malcolm Harvey

Atomic Energy of Canada Limited
Chalk River, Ontario, Canada

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About the Reviewer: Malcolm Harvey gained an Honours BSc (1st Class) in mathematics at the University of Southampton in 1958 and then a PhD in applied mathematics in 1961 studying first with H. A. Jahn and then J. P. Elliott. His thesis was concerned with a "New Method for Calculating Spectra of Light Nuclei" and dealt with the application of the group SU_3 as applied to nuclear structure. A National Research Council of Canada fellowship brought him to Chalk River in 1961 where he joined the staff in the Theoretical Physics Branch in 1962. Apart from a year spent on a Ford Foundation Fellowship in the Niels Bohr Institute in Copenhagen, he has remained at Chalk River. His professional interests are in the many-body problem as it exists in the atomic nucleus with the application of group theory.

Linear Transport Theory. By Kenneth M. Case and P. F. Zweifel. Addison-Wesley Publishing Co. (1967). 342 pp. \$17.50.

All students of neutron transport theory are aware of some of Professor Case's many contributions to the field. It is therefore a particular pleasure to welcome this authoritative and clear exposition of linear transport theory, or one-speed neutron transport theory as the work might almost equally well have been entitled. In some respects, this book is a successor to the earlier volume "Introduction to the Theory of Neutron Diffusion" by Case, deHoffmann, and Placzek. In both, the emphasis is on one-speed theory and on a thorough description of those few problems that have been solved in closed form. In the present volume, the class of solved problems is carried a good deal farther, partly because some progress has been made in the last 14 years and partly because the earlier Placzek work was designed to be followed by an analysis of further standard problems. Moreover, the present volume differs from its predecessor in that the standard problems are all solved by application of the method of singular eigenfunction expansion (commonly called Case's method) rather than Fourier transform or other techniques.

The book begins with a section on general properties of the transport equation and its solutions, including a belabored bit on symmetry properties and some nice material on uniqueness, Green's functions, and reciprocity. This is followed by a chapter on transport in purely absorbing media, including a development of integral theory and escape probabilities.

In the middle half of the book, the method for solving the one-speed transport equation by expansion in singular eigenfunctions is systematically formulated. Completeness and orthogonality of the eigenfunctions is proved and application is made to standard problems including the infinite-medium Green's function, half-space Green's function, Milne problem, albedo problem, and critical slab problem. The time-dependent infinite-medium Green's function is found in two different ways. Most of the development is for problems in plane geometry, but it is

indicated how some results can be generalized to spherical or even to cylindrical geometry.

Numerical methods are next discussed, notably the P_L and S_n methods, and some comparisons (not all correct) are made with the exact results for standard problems. The method of invariant imbedding is described briefly. Finally, it is shown how the methods that were formulated for neutron transport can be applied to other fields of physics, including sound propagation, radiative transfer, and plasma theory. In a series of 12 appendixes some mathematical aspects are treated in some detail.

A student confronting this work should presumably have some familiarity with more elementary treatments of transport problems. In addition, he must know some theory of functions of a complex variable. The reviewer wondered whether it might even have been worthwhile to include a chapter reviewing relevant aspects of this theory and introducing methods for solution of singular integral equations. However, the level of mathematical complexity seems to have been kept near the necessary minimum. Indeed, the authors chose not to discuss some important problems, including the spectrum of operators in boundary-value problems, so as to avoid the mathematical difficulties.

In summary, this book contains an elegant and unified treatment of the most important solved problems in one-speed neutron transport theory. From a practical point of view, a knowledge of these solved problems is useful, first of all for developing intuition concerning solutions of transport problems in general, and more importantly, for comparison with solutions obtained by practical numerical methods so that one may judge their accuracy. This book, when combined with the extensive tabulations in the earlier Placzek work, should prove very useful for both purposes.

George I. Bell

Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

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About the Reviewer: George Bell is a member of the Theoretical Physics Division of the Los Alamos Scientific Laboratory. His work in reactor physics includes contributions to the theory of cavity reactors, resonance absorption, neutron transport, and stochastic theories of neutron multiplication. He is a fellow of the American Nuclear Society and the American Physical Society.

Introduction to Quantum Theory of Scattering. By Leonard S. Rodberg and R. M. Thaler, Academic Press (1967). 389 pp. \$11.50.

This book is addressed to the graduate student having a background in quantum mechanics of about one year. It concentrates on a few of the central ideas of scattering theory and has the unique feature of going at some important problems, such as potential scattering, from several different viewpoints. A particularly clear account is given in Chap. 2 of the wave-packet description and the justification of the stationary-state description of scattering. Chapters 3, 4, and 5 are devoted to the formulation of the differential and integral equations for potential scattering. Methods of solving these equations are presented and the commonly used approximations are discussed.

The next four chapters are devoted to more general methods and processes, including the operator formalism time-dependent approach, the S and K matrices, and

inelastic and rearrangement collisions. Chapter 10 contains a discussion of invariance principles and their implications for scattering. In Chap. 11, the modifications necessary in the case of particles with spin are discussed. The final chapter is concerned with rather different topics, such as the distorted-wave approximation, scattering by a many-body system, and deals with the optical potential and resonances. The book is non-relativistic but attempts to carry out many of the discussions in the form which lends itself to generalization into the relativistic domain. The authors have paid considerable attention to details. For example, they adopt a consistent notation throughout the work.

A possible weakness of the book is the fact that it contains practically no illustrations of theory in relation to experimental data. This raises a question of philosophy as to whether in a first treatment of scattering it is wise to be concerned exclusively with the mathematical aspects of the scattering theory in contrast to its applications to atomic or nuclear physics. Here one is confronted with the prejudices of the reviewers who tend toward the feeling that the mathematics of scattering may be viewed as a branch of applied mathematics, whereas scattering theory together with representative applications becomes a branch of physics. Apart from this possible philosophical prejudice, the book deserves considerable praise.

All in all, the authors have produced a clearly written and useful book that is intermediate in scope between the all-too-brief treatments given in quantum mechanics texts and the comprehensive treatments such as Goldberger and Watson and Mott and Massey.

A. E. S. Green
B. S. Thomas

University of Florida
Gainesville, Florida 32601

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About the Reviewers: Alex E. S. Green has been a Graduate Research Professor in the Department of Physics and Astronomy at the University of Florida since 1963 where he is conducting theoretical research programs in aeronomy and in meson-nuclear physics. Dr. Green received his graduate degrees from California Institute of Technology and the University of Cincinnati following earlier training at the College of the City of New York. He has held academic appointments at the University of Cincinnati and at Florida State University, where he directed research with the tandem Van de Graaff, and from 1959 to 1963 he was at General Dynamics Convair as Chief of Physics and as Manager of the Space Science Laboratory.

Billy S. Thomas is an Assistant Professor in the Department of Physics and Astronomy at the University of Florida. He attended Wayne State University and completed his graduate work in 1959 at Vanderbilt University. Dr. Thomas was a National Research Council Fellow. At the University of Florida since 1960, he is currently working on the theory of atomic and molecular scattering.

The Theory of Neutron Slowing Down in Nuclear Reactors. By J. H. Ferziger and P. F. Zweifel. Pergamon Press (1966). 310 pp. \$13.50.

Sciences, today, tend to grow into maturity at a rather early age. Like many other new sciences, reactor physics has developed very quickly since the end of the Second

World War. Perhaps for this reason the literature of reactor physics is somewhat disorganized. Much important work remains dispersed in obscure technical publications where it is difficult to find, and easily overlooked. Some of the best reactor physics work, the early work on slowing down, used to be the least accessible, but I'm happy to see that, thanks to the efforts of Ferziger and Zweifel, this is no longer true.

In their book Ferziger and Zweifel cover several different, though related, topics. They are at their best, I think, in sections dealing with a field one might call "classical" slowing down theory. I refer, here, to studies by Placzek and Marshak on slowing down in infinite media; to the P_L and B_L approximations in simply buckled systems; to the age, Selengut-Goertzel and Greuling-Goertzel approximations; to the moments method, and the theory of slowing down kernels. All these topics are treated very well.

In one section, for example, the authors discuss the relation between the B_L and P_L approximations. They bring out very clearly the various connections between these approximations, and the reasons for the superiority of B_L over P_L methods. Another particularly interesting section deals with the form of the differential cross section for elastic scattering. Ferziger and Zweifel show how this cross section is constructed, from its center of mass components, with the aid of the T_{LL} transformation matrices. Though the notation and techniques used here were developed some time ago by Hurwitz and Zweifel, their approach is probably still unfamiliar to many reactor physicists. I suspect that most readers will find both these sections, and many others like them, extremely helpful.

One gets the impression that classical slowing down theory is the principal subject of this book. Many other subjects are discussed, but they are not handled with nearly as much skill and care. Thus, for example, the sections on resonance capture have important defects. The term "resonance integral" is used, but is not very clearly defined. The NRIA equations are not explicitly derived, and they are written incorrectly on pp. 103 and 109. Moreover, the authors do not mention the development of the IR approximation, the most important development in the theory of resonance capture since 1962.

There are weaknesses, also, in the treatment of transport theory. It is asserted, on p. 138, that interface conditions in P_L approximations are trivial, and that all P_L moments are continuous at interfaces. But this is true only in one dimension, and only when L is odd. In fact, it is not very easy to derive interface conditions that are appropriate for use in multidimensional spherical-harmonics equations.

On p. 140 there is an error for which Ferziger and Zweifel cannot really be held responsible. The authors say that Marshak's boundary conditions are more accurate than Mark's in low P_L approximations, but less accurate in high approximations. This theory seems to have originated in Davison's book, and it was widely accepted when Ferziger and Zweifel wrote their book. Recent numerical work by Pellaud (*Trans. Am. Nucl. Soc.*, 9, p. 434) and by Schmidt and Gelbard (*ibid.*, p. 432) indicates, however, that Marshak's conditions are generally better than Mark's in all P_L approximations.

In summary I would say that Ferziger and Zweifel have written a very good book on classical slowing down theory. Their book will also be useful to many students as an introduction to resonance escape theory, to transport theory, and to the numerical methods used in reactor