Book Reviews

Thermodynamics of Linear Transport Processes. By Marjan Ribaric. Slovene Academy of Sciences and Arts, Ljubljana, Yugoslavia (1975). 158 pp.

This short book is an attempt to construct a type of theory for linear transport processes that has long existed for gas dynamics: a macroscopic theory expressed in terms of thermodynamic quantities such as density, pressure, and entropy. In the author's own words, "it is the aim of this work to present a linear microscopic model of transport phenomena which allows one to establish a mathematically correct and conceptually clear connection between the corresponding macroscopic descriptions of the same physical phenomenon."

The author's approach is basically the same as that in his earlier books, *Functional Analytic Concepts and Structures of Neutron Transport Theory*, Vols. I and II, which were reviewed in this journal by the present reviewer [*Nucl. Sci. Eng.*, **58**, 105 (1975)]. This approach entirely avoids the linear transport equation by hypothesizing instead a list of qualitative physical and mathematical assumptions concerning the linear transport of material particles. (This is the author's "model.") These assumptions are treated as axioms and are used to develop a black box theory in which qualitative relations are obtained between the incoming and outgoing particle currents on the surface of a material body. Additional results are obtained by regarding any large body as the union of its constituent parts, and by suitably relating the surface currents of these constituent parts.

In the present work, this theory is applied to a special kind of transport process: At each point in the physical medium, the scattering operator conserves particles, i.e., if one neutron enters a collision, then one neutron leaves it. Furthermore, the physical medium is surrounded by an "isolating wall" that promptly reflects back into the medium any particle which strikes the medium's outer boundary. (The relevance of the author's theory to neutron transport processes is apparently weakened by these assumptions.)

The author then defines certain macroscopic quantities—i.e., neutron content, pressure, and entropy—in terms of the surface currents of the constituent parts of the physical domain. Some of these definitions seem rather intricate, but nevertheless, the author proves a large number of qualitative physical properties appropriate to these quantities. For a simple example, in an isolated system the author shows that entropy increases in time to a constant limiting value.

In the last section of the book, the author discusses one-dimensional neutron transport in a stack of plane-parallel plates and attempts to relate this to diffusion theory. His stated aim, in fact, is to obtain an improvement to diffusion theory. However, the analysis is largely qualitative, numerous approximations are made, and the result is a system of convolution-integral equations, the usefulness of which is unclear. In addition, there seems to be little connection between this section and the previous ones.

The stated aim of this book is certainly purposeful, and many of the author's results are interesting theoretically, if not being practically useful. Since a useful macroscopic theory has existed for many nonlinear phenomena, the development of such a theory for linear transport processes would be a promising endeavor. However, I believe that the author's approach has certain shortcomings.

First, much of the theoretical foundation for this work is based on the author's earlier volumes (mentioned above), and so certain criticisms of the earlier work apply here also. In particular, certain of the basic "model" assumptions that the author has used to build his theory are inconsistent with results that can be derived from the linear transport equation. For one example, the albedo operator for a body, which defines the outgoing current in terms of the incoming current, is *not* compact as the author assumes. It is possible that by weakening the author's "model," these inconsistencies can be removed without damaging the resulting theory. However, to do this would certainly add to the theory's length and complexity.

In addition, most of the author's results are qualitative and cannot be used to solve a legitimate reactor problem. Also, the notation and mathematical formalism is of sufficient complexity to probably render most of the analysis beyond the scope of the general reader. (The author admits, in his Preface, that it took "a period of more than one year . . . to find somebody competent and able to read the finished manuscript.")

In short, this work is qualitative, at some points in conflict with the neutron transport equation, specialized, and higher theoretical. At the same time, if it were developed along suitable lines, the theory might potentially be useful. In his Preface, the author briefly discusses "whether it is worth bothering to learn a new mathematical formalism comprising a new language of theoretical physics." Certainly there are many ways one can study any given subject, particularly linear transport theory. The virtue of certain approaches is that they provide, in a simple manner, practical and useful information on the subject that is not provided by other methods. For the present author to convince engineers and physicists of the virtue of his approach, he should in the future demonstrate that his approach *does* provide new and literally useful information, and he should endeavor to communicate this information in a simpler way.

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About the Reviewer: Edward Larsen has been an assistant professor of mathematics at New York University since 1971. During that time he has worked at the Courant Institute of Mathematical Sciences on applied mathematical methods in transport theory. Dr. Larsen did his undergraduate and graduate work at Rensselaer Polytechnic Institute. Apart from transport theory, his other main interests are asymptotic methods, applied functional analysis, and wave propagation.

The Equations of Radiation Hydrodynamics. By G. C. Pomraning. Pergamon Press, Inc., Elmsford, New York (1973).

This is a good book. Pomraning tells what the book is for and what it is about: the derivation of equations of the interaction of radiation with matter in various approximations and with motion and relativistic effects. He develops the equations and then he tells us what he has told us, the classical prescription for a good lecture or a good book.

I read the book with interest as an old neutron man who has had little dealing with plasmas; I had much to learn and enjoyed the opportunity of recognizing the sources and parallels with neutron transport theory. The book will serve admirably as a monograph on the subject, justly meeting the author's claim which does not extend (nor does he here provide) to methods of solving the equations.

I liked the economy of effort that cut out unnecessary mathematical technique in tensor notation when the development of the equations in relativistic motion did not require it. I was left a little confused around p. 159 in the discussion in the energy levels at which Thompson and Rayleigh scattering become dominant. I have to say something to prove that I read the book with a critical eye, and on this basis I offer a right-hand square bracket for equation 8.82 in a book that otherwise does both author and compositor credit for its remarkable freedom from typographical error.

It is a book at the graduate level that will be wanted by those working with plasmas (in practice or theory) and hence in preparing digital codes for description of fusion reactors. Pomraning has done the community a service by his careful collection and development of the equations, delivered with economy and panache.

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About the Reviewer: The reviewer, who is active in the British Nuclear Energy Society and Institution of Nuclear Engineers, is also a Fellow of the American Nuclear Society and past chairman of the local section in central Europe. Dr. Lewins recently spent a period visiting the Nuclear Engineering Department of the University of Alexandria to learn about and contribute to the Egyptian nuclear power program. His own interests are in the variational method extending through perturbation theory and optimization methods.