Particle transport processes

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Transport Theory. By J.J. Duderstadt and W.R. Martin. Pp.613. (Wiley: New York and Chichester, UK, 1979.) £24.

THE study of particle transport processes in a wide variety of fields has been a growing area of activity for a number of years. Inevitably, the developments in the various fields have been largely independent and the underlying similarity of the governing equations for particle transport has been somewhat neglected. This book continues and enhances the modern trend of providing a common basis and methodology for the study of all transport processes and brings together an armoury of techniques for the solution of transport problems.

The fundamental proposition of the book is that transport theory is the mathematical discipline associated with the solution of transport equations. This restricted, but valid, view leads to a volume which is more suited to applied mathematicians than to physicists or engineers. The essential physics of any transport problem is the derivation of a kinetic equation for the problem, the evaluation of the various scattering cross-sections and a statement of the boundary conditions. Of these, only the derivation of kinetic equations is given significant attention in this book. However, the familiar Boltzmann, Fokker–Planck and Vlasov transport equations are obtained with minimum fuss and a short description of the projection operator methods for the derivation of more general transport equations is included. The relationships between the kinetic equations, continuum theory and non-equilibrium statistical mechanics are given a careful and useful exposition.

The elegant mathematical techniques for the solution of transport equations in the integro-differential or integral form, which make up the essence of the book, are well presented. First the simplest transport equations for idealised non-scattering single energy systems are solved and then several more complicated problems are attacked. The necessary mathematical tools are generally developed as required, but a potential reader should already be well versed in integral transforms, boundary value problems and complex variable analysis before attempting the book. Otherwise the treatment of integral equations will be insufficient and the "Child's Primer on the Spectral Theory of Operators", provided in an appendix, will remain obscure. The tool kit for the solution of transport problems is completed by a discussion of numerical methods including finite element techniques and the Monte Carlo simulation methods.

The full battery of mathematical tools is unfortunately applied to very few practical examples in a few problems surprisingly included at the end of every chapter. It is rather as if, when training a mechanic, the theory of a screwdriver was carefully explained but he was never required to use the device to undo a screw. As a practical scientist I found this aspect of the book disappointing since the fields to which transport theory can be applied range from the important subject of neutron distributions in nuclear reactors through light propagation in stellar atmospheres to vehicular traffic flow.

However, the book is written with sufficient humour and insight to lift it above the level of a mere compendium of mathematical methods. In any event, no scientist interested in more than a phenomenological description of particle transport should be without this volume.

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Signal processing

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An Introduction to Statistical Signal Processing, with Applications. By M.D. Srinath and P.K. Rajasekaran. Pp.499. (Wiley: New York and Chichester, UK, 1979.) £18.30. *Digital Signal Processing and Control and Estimation Theory: Points of Tangency, Areas of Intersection, and Parallel Directions.* By A.S. Willsky. Pp.256. (MIT Press: Cambridge, Massachusetts, and London, 1979.) $22.50; £13.50.

THERE are already numerous introductory textbooks on signal processing but the temptation to turn their lecture notes into a textbook continues to be found irresistible by some university lectures. Furthermore, in such a subject, which is expanding into new areas, there is always some fresh application to mention that was not covered in earlier texts. The first of these two volumes is just such a book; it arose from various courses of lectures in the Southern Methodist University (Dallas) and two Indian institutes, and covers detection and estimation theory in commucations, radar, pattern recognition and system identification. It is a competent if uninspired work, clearly written for the most part though rather pedestrian in tone, and contains many worked examples, for which students will be grateful. Although it is described by the authors as a graduate text, much of the material is taught at undergraduate level in British universities, and for this audience, the book is probably too detailed: lecturers and students alike will probably find that their preferred text on signal processing, supplemented by a volume on two-dimensional questions in general (pattern recognition, image processing and the like), is more suitable.

Willsky's book is a very different matter. The author is a control theorist who was struck by the fact that work in digital processing and in control and estimation theory has a great deal in common, as well as certain clear differences that are themselves illuminating. There is no doubt that these two groups of subjects have much to offer one another and the author explores a range of topics from both points of view.

This kind of book is in the best sense a piece of self-indulgence on the part of the author, a leisurely examination of difficult problems and unsolved questions by a wide-ranging mind, not under any immediate compulsion to provide solutions. The result is an enjoyable and stimulating book, easy to read despite the advanced nature of the contents although the reader is expected to be familiar with the vocabulary, verbal and mathematical, of the subject. There are five main chapters, concerned with (1) the analysis of stability, (2) parameter identification and related topics, (3) synthesis, realization and implementation, (4) multiparameter systems, distributed processes and random fields, and (5) nonlinear system analysis.

The flavour of the text is well illustrated by the opening remarks of the chapter on multiparameter systems, which is much concerned with image processing: "This area is rich in both potential applications and challenging theoretical problems . . . How does one process distributed data efficiently? What properties do recursive techniques have when the recursion is in more than one dimension? Do causality and state make any sense here? What about stability? What are the tools for analyzing stochastic processes? How do we "predict" when time is not the independent variable? What role do recursive estimation techniques play? What are recursive estimation techniques? Which concepts concerning signals and systems in one independent variable carry over to the multiparameter case? Which do not, and why don't they?". Altogether an interesting and provocative book.

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