Book Review

METHODS IN NONLINEAR PLASMA THEORY
Ronald C. Davidson
(New York, Academic Press 1972, 356 pages)

Dr. Davidson's book represents a long-awaited, comprehensive work on the subject of nonlinear processes in a plasma. It is divided into coherent (wave-phase information taken into account) and turbulent (wave-phases randomly characterized in some sense) nonlinear phenomena. A development of coherent nonlinear phenomena takes up the first half of the book. This is sub-divided further into weakly nonlinear dispersive systems, solitons, strongly nonlinear nondispersive systems, strong wave-particle interactions or trapping, BGK equilibria and stability, echoes, and coherent nonlinear wave-wave interactions.

The second half of the book is devoted to a discussion of turbulent nonlinear phenomena, including weak and moderate turbulence. The rigorous development of weak turbulence theory for wave-particle interactions is particularly good, including a discussion of the Vlasov cumulant hierarchy and relation to the BBGKY hierarchy. A detailed time, velocity, and energy scale analysis and physical interpretation for the quasilinear wave particle theory applied to the "bump on the tail" problem is well-done. The relation of the theory to computer simulation experiments is presented with a detailed check of the relation of the simulation parameters of the approximations necessary for the quasilinear theory to provide an adequate description. The quasilinear wave-particle theory is then applied to a variety of problems, including the ion loss-cone instability and electromagnetic instabilities.

The weak turbulence theory for nonlinear wave-wave interactions, including three-wave and four-wave processes, is presented next. Finally, the general weak turbulence theory of nonlinear electrostatic interactions, including nonlinear wave-particle, wave-wave, and linear wave-particle effects using the Vlasov cumulant hierarchy is presented.

The book represents the most complete work to date on the introduction to nonlinear plasma phenomena. Up to date, detailed references in the text and at the end of each chapter on the theoretical work done in the area and related experimental and computer simulation work greatly enhance the scope of interest of the book.

The book is excellent for self-study for scientists and engineers in the plasma area who desire to review the field of nonlinear plasma phenomena. The reviewer has used the book in an interdisciplinary graduate course at The University of Wisconsin after the students had had a foundation three-course series in basic plasma physics, wave theory and instabilities, and kinetic theory. Many of the subjects treated in the text required supplementary mathematical methods and more detailed development and motivation for a particular theoretical approach than as presented in the text. Although use of "homework" problems at this level is debatable, the reviewer prepared a significant number (25) as the text does not contain them. Also missing in the text is a discussion of spatial problems rather than strictly temporal ones: because of the relevance of such to experimental verification and observation.

In conclusion, I believe it is an excellent book and much better than earlier published books in the area in clarity, accuracy, and completeness.

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