Book Review

Introduction to Plasma Theory. By Dwight R. Nicholson. John Wiley and Sons, Inc., New York (1983). 292 pp. $31.95.

Among the many books that have been published in recent years, *Introduction to Plasma Theory* by Dwight Nicholson comes closest to covering the ideal number and level of topics suitable for a first-year graduate course in plasma physics. Reflecting, perhaps, the author's interest, the book contains several chapters on the statistical description of plasmas, which has not figured prominently in any book since *Plasma Kinetic Theory* by Montgomery and Tidman (McGraw-Hill Book Company, 1964). Although lucidly presented, some of the material would have appealed more to the student with the standard undergraduate preparation had it been presented in a more familiar form. For example, the Louisville equation in Chap. 3 would have been more recognizable had it been put in the usual form containing the Poisson bracket of the probability density with the Hamiltonian. That, of course, would have necessitated deriving the Hamiltonian of a system that consists of particles and (external and internal) electromagnetic fields so as to portray the dynamics of interacting charged particles that one would expect in a realistic plasma. Moreover, the Boltzmann equation, perhaps the most fundamental of the plasma equations, was nowhere to be found in its standard form with the collision integral explicitly shown. It would appear that a chapter on transport processes in plasma dealing with the Boltzmann equation and the Fokker-Planck equation, which is presented as a byproduct of the discussion on the Lenard-Balescue equation, would have made a welcome addition to the text. A less serious omission is a section on the relativistic Vlasov equation.

The order of Chaps. 7 ("Fluid Equations") and 8 (Magnetohydrodynamics") should be reversed, since in their present form, they could convey an erroneous notion to the student or the uninitiated reader. With collisions being perhaps the most fundamental property of fluids, it would appear paradoxical to derive the fluid equations from the *collisionless* Boltzmann or Vlasov equation. It is more appropriate to first derive the magnetohydrodynamics equations by taking the appropriate moments of the Boltzmann equation and then to indicate under what approximations the one- and two-fluid equations of plasma can be generated. In the case of the two- (or more) fluid description, the force (or momentum) equation as derived from the appropriate moment of the Boltzmann equation would contain a momentum transfer vector between, say, species A and B. This quantity in turn can be expressed in terms of a collision frequency, which one could ignore under appropriate conditions, thereby producing the result given by the author. On the other hand, the one-fluid equation generally obtained by combining the equations for the species involved completely circumvents the problem, since the momentum transfer vanishes on summing over the interacting species; i.e., no approximations need be made about collisions. In short, the intuitive picture of a fluid as consisting of highly collisional components is preserved if Chap. 8 is first introduced and Chap. 7 is subsequently discussed to delineate the approximations invoked in deriving the one- and two-fluid equations of plasma.

It is regrettable that the author did not complement the lucid discussion of the "test particle" method presented in Chap. 9 with some applications in the area of radiation such as bremsstrahlung. He relegated that to some of the references at the end of the chapter and avoided tackling the problem by noting that "since these processes involve collision of two charged particles, it is not sufficient to use the simple test charge theory that we used for electrostatic fluctuations." It is not clear that one cannot use the charge density and, through the continuity equation, the current density to play the role of the test source in calculating the radiation fields and the corresponding radiated power. It would be pleasing to the student to compare the collective model on bremsstrahlung with the noncollective result generally presented in elementary texts.

An introductory course at the senior undergraduate level can indeed be effectively taught, as the author indicated in the preface, by using the material in Chaps. 1 and 2 followed by Chaps. 7 and 8. It is not clear, however, that a two-semester undergraduate course can be taught without including other chapters in the book that contain much too sophisticated concepts for most undergraduates. At the graduate level, the author emphatically notes that "no previous knowledge of plasma physics is assumed," even though a statement to the effect that it might be highly desirable may be more appropriate.

In short, the book can indeed serve as a very effective graduate text if the points raised above can be addressed and supplementary material is provided by the instructor.

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