<<等离子体物理学基础>>

图书基本信息

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前言

This text is intended as a general introduction to plasma physics and was designed with the main purpose of presenting a comprehensive,logical, and unified treatment of the fundamentals of plasma physics based on statistical kinetic theory. It should be useful primarily for advanced undergraduate and first-year graduate students meeting the subject of plasma physics for the first time and presupposes only a basic elementary knowledge of vector analysis, differential equations, and complex variables, as well as courses on classical mechanics and electromagnetic theory beyond sophomore level. Some effort has been made to make the book self-contained by including in the text developments of fluid mechanics and kinetic theory that are needed. Throughout the text the emphasis is on clarity, rather than formality.The various derivations are explained in detail and, wherever possible,the physical interpretations are emphasized. The equations are presented in such a way that they connect together, without requiring the reader to do extensive algebra to bridge the gap. The features of clarity and completeness make the book suitable for self-learning and for self-paced courses. The structure of this book is as follows.Chapter I consists of a basic introduction to plasma physics, at a descriptive level, intended to give the reader an overall view of the subject. The motion of charged particles under the influence of specified electric and magnetic fields is treated in detail in Chapters 2, 3, and 4. In the next five chapters the fundamental equations necessary for an elementary description of plasma phenomena are developed. Chapter 5 introduces the concepts of phase space and distribution function, and derives the basic differential kinetic equation that governs the evolution of the distribution function in phasespace. The definitions of the macroscopic variables in terms of the phase space distribution function are presented in Chapter 6 and their physical interpretations are discussed. The Maxweil-Boltzmann equilibriumdistribution function is introduced in Chapter 7, as the equilibrium solution of the Boltzmann equation, and its kinetic properties are analyzed in some detail. In Chapter 8 the macroscopic transport equations for a plasma considered as a mixture of various interpenetrating.fluids are derived, whereas the macroscopic transport equations for the whole plasma as a single conducting fluid are developed in Chapter 9. The remainder of the book is devoted to applications of these basic equations in the description of a variety of important phenomena in plasmas. The problems of electrical conductivity and diffusion in plasmas are analyzed in Chapter 10, and other basic plasma phenomena, such as electron plasma oscillations and Debye shielding, are treated in Chapter 11.Simple applications of the magnetohydrodynamic equations, such as in plasma confinement by magnetic fields and the pinch effect, are presented in Chapters 12 and 13. The subject of wave phenomena in plasmas is organized in the next six chapters. A review of the basic concepts related to electromagnetic wave propagation in free space is given in Chapter 14.The propagation of very low frequency waves in a highly conducting fluid is analyzed in Chapter 15, under the title of magnetohydrodynamic waves.The various modes of wave propagation in cold and warm plasmas are considered in Chapters 16 and 17, respectively. In Chapters 18 and 19 the various properties of wave propagation in hot nonmagnetized plasmas and in hot magnetized plasmas, respectively, are analyzed. Collisional phenomena in plasmas are treated in Chapter 20, and the derivations of the Boltzmann collision integral and of the Fokker-Planck collision term are presented in Chapter 21. Finally, in Chapter 22 some applications of the Boltzmann equation to the analysis of transport phenomena in plasmas are presented. Problems are provided at the end of each chapter, which illustrate additional applications of the theory and supplement the textual material.Most of the problems are designed in such a way as to provide a guideline for the student, including intermediate steps and answers in their statements. The numbering of the equations, within each chapter, starts over again at each section. When reference is made to an equation using three numbers, the first number indicates the chapter and the last two numbers indicate the section and the equation, respectively. Within the same chapter the first number is omitted. Vector quantities are represented by boldface type letters (such as r) and unit vectors by a circumflex above the corresponding letter (such as r). Dyadic and triadic quantities are represented by calligraphic type letters (such as Q). The system of units used in this text is the rationalized MKSA. This system is based on four primary quantities: length, mass, time, and current. Its name derives from the units meter (m), kilogram (kg), second (s), and ampere (A). The book contains more material than what can normally be covered in one semester. This permits some freedom in the selection of topics depending on the level and desired emphasis of the course, and on the interests of the students. The whole text can also be adequately covered within two semesters. In this, as in any introductory book, the topics included clearly do not cover all areas of plasma physics. No attempt was made to present the experimental aspects of the subject. Moreover, there are some important theoretical topics that are covered only very briefly and some that have been left for more advanced courses on plasma physics, such as plasma instabilities, plasma radiation, nonlinear plasma theory, and plasma turbulence. I am grateful to the many people who contributed to this book, both directly and indirectly, and especially to the many students to whom I had the opportunity to test my ideas in the various courses I taught over the last twenty-five years. The amount of digitalized information in a book such as this is truly enormous, and some errors may be bound to occur.Further feedback from readers will be appreciated. I wish to thank the many professors, students, and researchers who have used the first two editions of this book, all over the world, and contributed to its improvement.

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内容概要

本书系统地介绍了等离子体物理学的基本理论及其在很多重要等离子体现象中的应用。
本书内容全面，结构合理，阐述清晰。
作者注重表达的简洁性，没有拘泥于形式，对自学和进阶很有好处。
从统计动力学讨论等离子体现象是本书的一大特色。
另外，作者对数学处理技巧说明得非常详细，列举了数学推导的中间步骤，这些通常是留给读者自己完成的，同时强调了这些公式的物理解释，帮助读者获得更深入的理解。
书中设计的习题是内容的重要组成部分，也是进一步提高的出发点。
阅读本书需要经典力学和电动力学的基本知识。

本书适合于初次学习等离子体物理的高年级本科生和一年级研究生，同时也适用于对等离子体现象以及相关领域诸如空间物理和应用电磁学等感兴趣的研究人员。
目次：简介；稳恒和均匀电磁场中的带电粒子运动；非均匀静磁场中的带电粒子运动；随时间变化的电磁场中的带电粒子运动；等离子体动力学理论基础；平均值和宏观变量；平衡态；宏观输运方程；导电流体的宏观方程；等离子体电导率和扩散；若干基本等离子体现象；磁流体动力学的简单应用；缩聚效应；自由空间电磁波；磁流体动力学波；冷等离子体波；暖等离子体波；热各向同性等离子体波；热磁化等离子体波；等离子体中粒子间相互作用；波尔兹曼和佛克尔—普朗克方程；等离子体中的输运过程；附录A：常用的矢量关系；附录B：迪卡尔坐标和曲线坐标中的常用关系；附录C：物理常数；附录D：物理单位间的换算因子；附录E：部分重要的等离子体参数；附录F：若干典型等离子体的近似量极；索引。

读者对象：物理，化学和材料专业的高年级本科生、研究生和相关专业的科研人员。

书籍目录

章节摘录

插图：

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