

Preface

Turbulence represents random motions of flow, and is one of the common experiences in our daily life as can be seen in air and water flow. Whether or not turbulence exists in the extraterrestrial world turns out to be one of the fundamental questions in understanding astrophysical systems. Stellar dynamics, interplanetary and interstellar space, cosmic ray, and accretion disks - these systems are largely maintained by the existence of turbulence, but their dynamical behaviors are substantially different from that of ordinary gas or fluid, since the medium is an ionized gas, called the plasma, and is electrically conducting.

Plasma turbulence is a challenge in physics both in theories and observations, and the aim of this book is to review plasma turbulence on the introductory level and also to review recent developments and knowledge obtained by Cluster, the multi-spacecraft mission. Cluster is a four-spacecraft mission in near-Earth space and has enabled us for the first time to determine spatial structures of space plasma dynamics. Different branches of physics are involved in plasma turbulence: fluid dynamics, electromagnetism and electrodynamics, plasma physics, geophysics, space, and astrophysics. Studying plasma turbulence requires these backgrounds, while progress in plasma turbulence research has mutual impacts on these subjects in return, bringing the different research fields together.

This book is organized in the following fashion. [Chapter 1](#) introduces the concept of plasma turbulence with its historical developments. [Chapter 2](#) is a review of theoretical building blocks for understanding plasma turbulence. [Chapter 3](#) presents the analysis methods for Cluster data. [Chapter 4](#) is a review of plasma turbulence studies using Cluster data in near-Earth space. [Chapter 5](#) presents the impacts of plasma turbulence on the related subjects: plasma turbulence as general physics problem, as astrophysics problem, and as Earth science problem.

Space plasma research has entered a new era with multi-spacecraft missions. It is a pleasure to the author if students and researchers in other fields become interested in physics in the extraterrestrial world, and use this book as a guide to this subject.

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