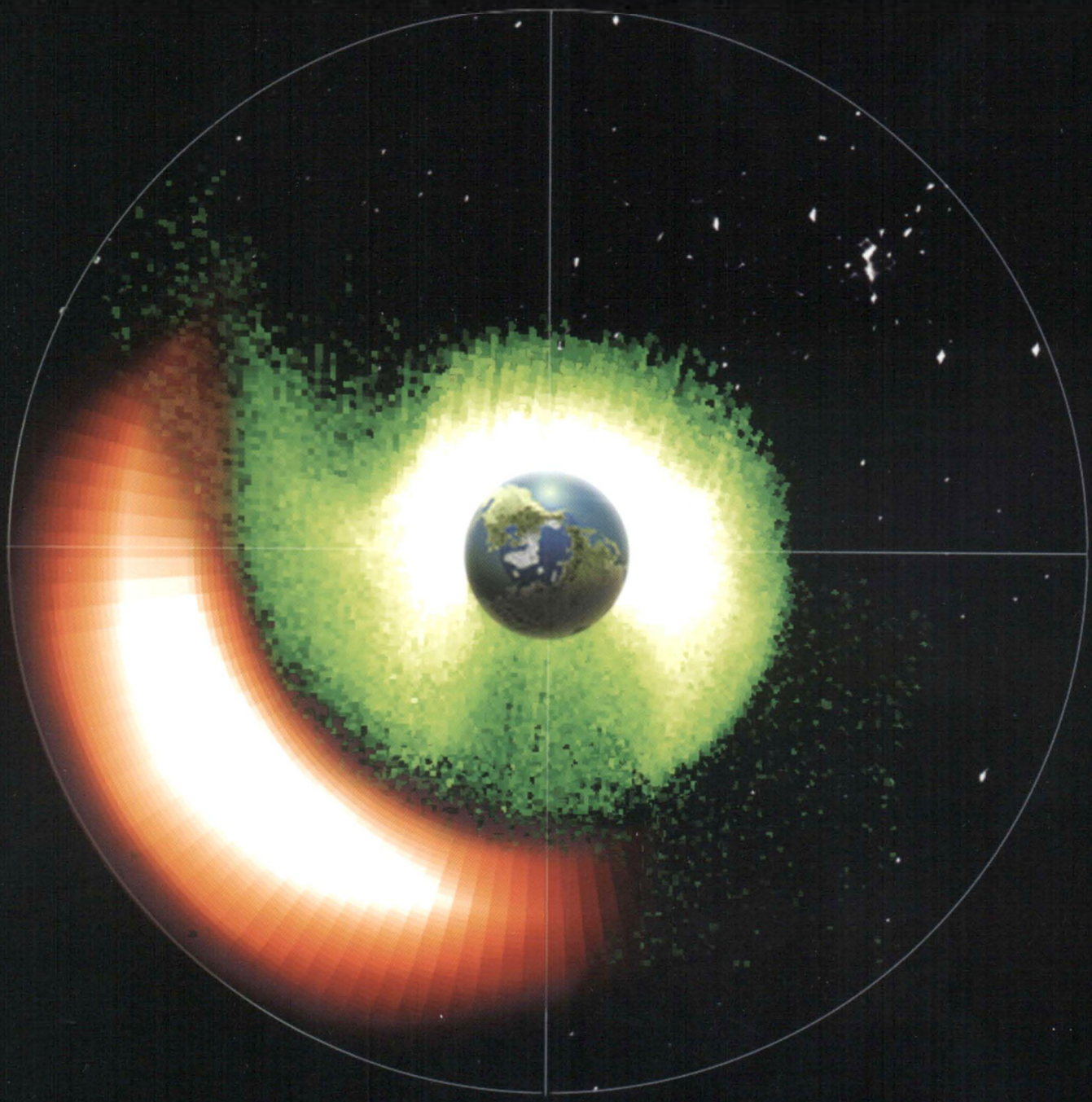
The Inner Magnetosphere
Physics and Modeling



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The Inner Magnetosphere: Physics and Modeling

Tuija I. Pulkkinen
Nikolai A. Tsyganenko
Reiner H.W. Friedel
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PREFACE

As we become a space-faring culture, there is an increasing need for reliable methods to forecast the dynamics of electromagnetic fields, thermal plasma, and energetic particles in the geospace environment, as all these factors affect satellite-borne systems. From the electrodynamics viewpoint, on the other hand, the inner magnetosphere is a key element in the Sun-Earth connection chain of processes. Most notably, it is a region where a significant part of the storm-time energy input from the solar wind is deposited and dissipated.

Because the most interesting and crucially important phenomena, as noted, develop relatively close to Earth (in the transition region separating the innermost quasi-dipolar geomagnetic field from the magnetotail), understanding them is a complex task. Moreover, the stronger the disturbance, the deeper its impact penetrates into the inner magnetosphere. In this region plasma no longer behaves like a fluid, and the motion of energetic charged particles becomes important for the dynamics of the system. This fact leaves "particle simulations" as a primary tool for studying and understanding the dynamics of the inner magnetosphere during storms. An integral element of such simulations is an electromagnetic field model. Recent studies of the inner magnetosphere have substantially improved our understanding of its dynamics while creating new paradigms and reviving old controversies.

In this book we focus on clarifying issues related to the physics and structure of the inner magnetosphere. Toward this end, David Stern introduces the main part of the monograph with a brief historical review of early ring current studies. Five sections follow. Section I, which deals with the sources and losses of plasma and energetic particles in the inner magnetosphere, opens with two invited reviews (by Jordanova and Koskinen) and includes five contributed papers. Section II concentrates on the acceleration mechanisms, as addressed in an invited review by Baker and in six contributed papers. Section III analyzes external driving mechanisms of the inner magnetosphere, a subject of a long-standing debate that recently gained renewed interest by way of latest particle simulation results. It opens with an invited review (Ganushkina), followed by five contributed papers. Section IV focuses on some observational aspects of inner magnetosphere dyamics. Its lead, review paper (by Green and Fung) on electromagnetic wave studies in the inner magnetosphere would equally well fit in sections I or II, as such waves are an essential factor in particle loss and acceleration processes. The last section V contains five papers on large-scale modeling efforts of the inner magnetosphere, including latest results from using the RCM approach in modeling electric fields as well as MHD simulations.

In our effort to organize a forum on current understanding of processes in inner geospace, a Chapman Conference on the Physics and Modeling of the Inner Magnetosphere was held August 25-29, 2003, in Helsinki, Finland. This monograph largely derives from papers presented at that meeting. The monograph became possible owing to the help of many people. We are grateful to the members of the Program Committee: Joe Borovsky, Ioannis Daglis, Toshihiko Iyemori, Janet Kozyra, Rumi Nakamura, Joe Lemaire, Xinlin Li, and Victor Sergeev. We acknowledge the many scientists who served as referees for the papers in this monograph, and who provided numerous helpful, candid, and insightful critical comments. Their names are given below in a separate list. We also thank AGU book staff for their expert help in developing and producing this book.

Financial assistance from the National Science Foundation, NASA's Living With The Star Program, Academy of Finland, and the Vilho, Kalle and Yrjö Väisalä Foundation made it possible to support the participation of several students and young scientists in the Conference. The local organizing committee and the staff at the Finnish Meteorological Institute are gratefully acknowledged for smooth running of the Conference.

Tuija I. Pulkkinen
Nikolai A. Tsyganenko
Reiner H.W. Friedel

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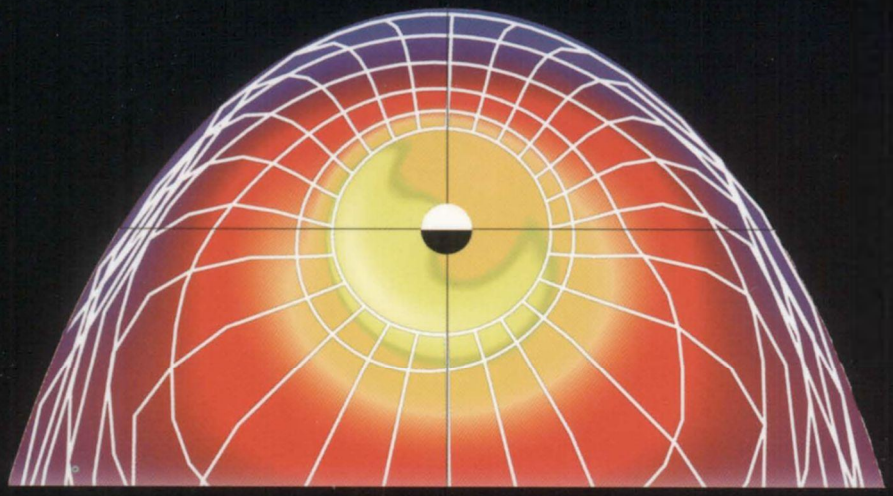

The inner magnetosphere is a key region for the science associated with space weather. How do we understand particle acceleration and dynamics in a multi-component plasma under highly variable electromagnetic fields during space storms, and how can we better predict the onset and effects of space storms?

In this book, we respond to such questions by presenting new advances in inner magnetospheric science, both in terms of observations and modeling, while depicting areas where progress is still to come. Five contexts predominate:

- Sources and losses of particle populations
- Energetic particle acceleration mechanisms
- External driving mechanisms
- Observational specifications
- Large-scale models

Scientists and students of magnetospheric physics, solar and heliospheric physics, aeronomy, and geomagnetism will find this book a critical resource for present and future studies on the inner magnetosphere.

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