

Foreword

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The Earth's plasmasphere can be regarded as the upward extension of the low- and mid-latitude ionosphere. While being located relatively close to Earth, on closed geomagnetic field lines, this region of the inner magnetosphere has turned out to be enigmatic: It is filled with cold plasma of ionospheric origin that is hard to detect, permeated by variable electric fields, and home to a zoo of plasma radio waves. It is also extremely dynamic as it responds in multiple ways to geomagnetic activity.

Plasmaspheric exploration got a major boost since 2000, when the CLUSTER and IMAGE spacecraft were launched. ESA's four CLUSTER satellites continue to orbit Earth in a coordinated constellation until today, visiting the plasmasphere on each perigee pass and returning correlated multi-spacecraft measurements. NASA's IMAGE spacecraft ceased operations after almost 6 years of discovery by pioneering global imaging and radio sounding techniques. These missions offered a new and different view of the plasmasphere. The past years have therefore been fruitful, and the body of scientific knowledge about the plasmasphere has grown significantly. It was felt, however, that the IMAGE and CLUSTER plasmaspheric science communities did not know each other's instruments and tools well enough, and that further efforts to exploit the data produced by these missions were desirable. This led us to organize the workshop "The Earth's plasmasphere: A CLUSTER, IMAGE, and modeling perspective" at the Belgian Institute for Space Aeronomy in the fall of 2007. This workshop provided an overview of what had been achieved by the two communities, and offered the starting point for writing this book as an integrated collection of six self-contained papers.

The first paper, "CLUSTER and IMAGE: New Ways to Study the Earth's Plasmasphere" reviews old and new techniques for exploring the plasmasphere. Particular attention is paid

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to the capability of the IMAGE and CLUSTER instruments to go beyond the traditional scheme of single-point in situ measurements. The paper highlights the novel data interpretation algorithms that are required to do so.

The cold plasma making up the plasmasphere is the subject of the second paper “Plasmaspheric Density Structures and Dynamics: Properties Observed by the CLUSTER and IMAGE Missions”. Plasmaspheric structures with large, medium, and small scales are discussed in the light of the new body of data. The size, topology, composition, and evolution of these structures are underscored.

The magnetic and electric fields dictate the behavior of the plasmasphere, as covered by “Electric Fields and Magnetic Fields in the Plasmasphere: A Perspective From CLUSTER and IMAGE”, the third paper. The electric fields reflect the dynamical response of the inner magnetosphere to the ever-changing solar wind–magnetosphere interaction, and are given particular consideration.

The plasmasphere hosts a large variety of wave phenomena. “Advances in Plasmaspheric Wave Research with CLUSTER and IMAGE Observations”, the fourth paper, shows how CLUSTER and IMAGE help to understand these wave phenomena, but also how these waves help to understand the physical processes.

The final two papers, “Recent Progress in Physics-Based Models of the Plasmasphere” and “Augmented Empirical Models of Plasmaspheric Density and Electric Field Using IMAGE and CLUSTER Data”, deal with our present abilities to model the rich variety of plasmaspheric structures and their evolution, as tested against the IMAGE and CLUSTER observations. These models help us to identify and understand the underlying physical processes. At the same time, they allow us to make predictions about the plasma and field environment in the inner magnetosphere.

Numerous specialists have contributed their time and energy to guarantee that this book provides an up-to-date overview of the state-of-the-art in plasmaspheric research. We hope that it can inspire the field for years to come. We are very much indebted to the CLUSTER and IMAGE project scientists, C. Philippe Escoubet and James L. Burch, for their support. The realization of this book has run smoothly thanks to the dedicated efforts of Harry J.J. Blom, Randy D. Cruz and Fiona Routley at Springer. We feel particularly obliged to all the reviewers who scrutinized the manuscripts to ensure a high quality and without whom this book would never have materialized: Mark L. Adrian, Robert F. Benson, Galina A. Kotova, Mark B. Moldwin, Pamela A. Puhl-Quinn, Mark A. Reynolds, Phillip A. Webb and two anonymous reviewers. We also gratefully acknowledge the financial support by the Belgian Institute for Space Aeronomy and by the Belgian Federal Science Policy Office.



Participants of the Workshop “The Earth’s plasmasphere: A CLUSTER, IMAGE, and modeling perspective” at the Belgian Institute for Space Aeronomy, 19–21 September 2007: 1. Dennis L. Gallagher, 2. Joseph F. Lemaire, 3. Hiroshi Matsui, 4. Viviane Pierrard, 5. František Němec, 6. Iannis Dandouras, 7. Bill R. Sandel, 8. Pierrette M. E. Décréau, 9. Farida El-Lemdani Mazouz, 10. Mark B. Moldwin, 11. Richard E. Denton, 12. Michel Roth, 13. Arnaud Masson, 14. Fabien Darrouzet, 15. Jerry Goldstein, 16. Nicolas André, 17. Bodo W. Reinisch, 18. James L. Green, 19. Johan De Keyser, 20. Donald L. Carpenter. Not present for the picture: John C. Foster