Preface

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Received: 8 May 2009 / Accepted: 8 May 2009 / Published online: 27 May 2009
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The IMAGE and CLUSTER spacecraft have revolutionized our understanding of the inner magnetosphere and in particular the plasmasphere. Before launch, the plasmasphere was not a prime objective of the CLUSTER mission. In fact, CLUSTER might not have ever observed this region because a few years before the CLUSTER launch (at the beginning of the 1990s), it was proposed to raise the perigee of the orbit to 8 Earth radii to make multipoint measurements in the current disruption region in the tail. Because of ground segment constraints, this proposal did not materialize. In view of the great depth and breadth of plasmaspheric research and numerous papers published on the plasmasphere since the CLUSTER launch, this choice certainly was a judicious one.

The fact that the plasmasphere was one of the prime targets in the inner magnetosphere for IMAGE provided a unique opportunity to make great strides using the new and complementary measurements of the two missions. IMAGE, with sensitive EUV cameras, could for the first time make global images of the plasmasphere and show its great variability during storm-time. CLUSTER, with four-spacecraft, could analyze in situ spatial and temporal structures at the plasmopause that are particularly important in such a dynamic system. In addition, IMAGE, using a powerful and sensitive sounder, determined for the first time the plasma density along magnetic field lines, which is key to understanding the refilling of the plasmasphere after an active period. On the other hand, CLUSTER could derive for the first time density and magnetic field gradients at the plasmopause and in the ring current using four-point measurements.

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Many discoveries and key results are highlighted in this book. While IMAGE obtained global images of He^+ content of the plasmasphere, CLUSTER was able to determine the ratios between H^+ , He^+ , and O^+ . Likewise, the plasma plumes viewed in a global context by IMAGE were seen to have complex spatial structure by CLUSTER. Many smaller scale structures have for the first time been observed, including “shoulders”, “channels”, “fingers” and “crenulations” that together depict the irregular behavior of the plasmasphere. Finally the extensive data sets from both missions have driven a strong modeling effort producing empirical and kinetic models that are absolutely necessary to understand globally the plasmasphere and its interaction with the ionosphere and the magnetosphere. Perhaps the greatest advantage was that both missions were operating simultaneously during many years.

We are grateful to the Belgian Institute for Space Aeronomy, the authors and referees of this book for preparing such comprehensive and detailed review articles that describe the history of plasmaspheric physics and the discoveries and fundamental results that have been obtained with CLUSTER and IMAGE. We hope that many students and scientists will enjoy reading it and find it useful in their research.