PREFACE

Introduced in 1958, the term magnetosphere refers to the magnetic cavity surrounding a celestial body. Invisible to the human eyes, magnetospheres can only be explored through the development of instruments, theories and numerical models. With the advent of the space age we have started exploring them in situ and accumulated an impressive amount of data over the years. Sixty years after the term magnetosphere was been defined, it is challenging to review the existing knowledge on solar system magnetospheres in one single book.

This book provides an overview of the magnetospheres in the solar system, from the small induced magnetospheres that form around unmagnetized bodies to the large magnetospheres of the giant planets. Magnetospheres are highly complex, structured and time-dependent systems constantly interacting with the solar wind and the components of the planetary systems, such as their ionosphere, atmosphere, surface, rings, and moons. Each magnetosphere is unique and contains various intertwining subregions, particle populations, and plasma processes. This explains the scientific interest of magnetospheric physics: magnetospheres are accessible natural laboratories for studying fundamental physical processes of universal application. Moreover, the Earth's magnetosphere is a key component of our near-space environment on which our modern societies are increasingly dependent.

The book is divided in eleven sections that cover the current state of our understanding as well as future directions for scientists. Part I starts with a brief history of magnetospheres and presents the basic principles and equations. Part II addresses the fundamental processes that govern magnetospheric physics. The three following sections are dedicated to the Earth's magnetosphere, the most studied and best known of the solar system magnetospheres. They respectively focus on its coupling with the Earth's ionosphere (part III), its coupling with the solar wind (part IV), and its dynamics (part V). The next sections are oriented toward other solar system bodies. After a discussion about planetary magnetic fields in part VI, we focus on the induced magnetospheres in part VII, on the magnetospheres of giant planets in part VIII and, in part IX, on "minimagnetospheres", such as those of Mercury and magnetized moons. Part X considers the tools that are used to investigate magnetospheric processes. Finally, part XI discusses the key questions and challenges to be addressed in the coming years, providing some insights on the future developments of magnetospheric research. The chapters contained herein include contributions from experimentalists, theoreticians, and numerical modelers.

We hope that this book will be a resource for both the novice researcher and the experienced scientist. For those less acquainted with current topics in Earth and planetary magnetospheric research, this book will provide the background material required to be knowledgeable on the current state of the art. For experts, it will act as a reference to the most important magnetospheric science breakthroughs and help expand the reader's horizons with its coverage of the diverse near-body regions in space. With this book, we hope that the reader will comprehend most of the features of magnetospheres and find the keys to delve as far as possible into them.

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This book is dedicated to the memory of Richard M. Thorne.

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