INTRODUCTION TO SPACE SCIENCE

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Introduction to Space Science

Robert C. Haymes

Rice University
Houston, Texas

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To my wife Jamie.
Without her constant encouragement,
this book would never
have been completed.

Preface

Space science may be defined as the scientific study of cosmic physical systems. It is among the oldest of intellectual pursuits and yet is one of the most challenging endeavors of the modern era.

The use of the word cosmic is intended to emphasize the importance of large-scale, collective phenomena; for example, the properties of collisionless plasmas of cosmic dimensions that have magnetic fields embedded in them cannot be studied in the laboratory because of the difficulty in scaling, yet shocks formed in such plasmas appear to be a very general and important feature of the behavior of matter. They may be responsible for the apparent acceleration of charged particles in the vicinity of the earth and also for the heating of electrons to high temperatures in the neighborhood of the huge discrete radio sources found throughout the known universe.

Space science is an interdisciplinary field; an understanding of many sciences, such as physics, chemistry, and geology, is required in order to understand our total environment. Space science draws on all of these, but the whole is greater than the sum of its parts.

This book is an outgrowth of a one-year course of the same name that my colleagues and I developed in the Department of Space Science at Rice University. The course is open to seniors and to first-year graduate students. A familiarity with college physics, such as the usual first-year course, is assumed, but no previous acquaintance with any of the areas of space science is necessary for the course. Another assumption is that the student is familiar with ordinary differential equations.

The planetary system and the interplanetary medium are discussed in the first 10 chapters. The earth and the near-earth space are used as models whenever possible. Most of the material contained within the first 10 chapters is usually covered during the first semester; the remainder, which emphasizes the sun and the contents of the space beyond the solar system, occupies the second term.

It will be seen that the length of the various chapters is uneven. The fundamental cause is that some areas of space science are better defined and

more knowledge is available than in others. I am most grateful to my colleagues within the Department at Rice, most notably H. R. Anderson, P. A. Cloutier, A. J. Dessler, J. W. Freeman, Jr., D. Heymann, R. P. Kovar, N. Soga, and W. H. Tucker, who have made many valuable contributions to various sections of the book. The responsibility for any errors or for obscurity of presentation, however, is mine alone.

We are not concerned, in space science, with technology. Very little will be found in this volume concerning observatories or vehicles such as balloons, rockets, satellites, or deep-space probes; the emphasis throughout is on the basic principles of the physical phenomena, together with a little speculation concerning future possibilities. We should note, however, that science and technology go hand in hand. One cannot proceed without advances in the other.

Space science may well result in some practical applications. Indeed, it has already resulted in many useful things, ranging from navigation and the calendar to the energy released by nuclear fusion and to improved global communication and weather forecasting.

Applications, however desirable, are not the main goal of science. Space science, like any of the other physical sciences, attempts to increase our understanding of nature and also to describe it as accurately and concisely as possible.

Applications of knowledge to the betterment of man's life cannot result unless there is a body of knowledge to draw upon. Space science represents the attempt by man to extend his knowledge of the physical universe. In my view, it requires no further justification than this for its continued vigorous existence.

Space science has raised more questions than it has answered; this is the excitement of the field. Many problems will undoubtedly remain unsolved for a very long period, but the attempt to resolve them is both fascinating and rewarding. It is the purpose of this book to introduce the reader to our quest for knowledge of the universe, and hopefully this introduction will lead to a sympathetic understanding of that quest.

R. C. HAYMES

Houston, Texas
March, 1971

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