Preface

This book is an attempt to create an up-to-date text on the physics of the solar system and the objects that make it up. It thus has a rather different outlook compared to books that focus on descriptive material, on geological ideas, or on chemistry and astro-biology, although aspects of all these approaches do appear in the book. I have tried to centre the discussions on the big ideas, on how things work, on what the structure and history of various bodies has been, and on why we accept some answers to our questions and reject others. Because of this approach, the book does not provide a complete survey of the enormous amount of information now available about solar system objects. Instead I have concentrated on subjects that are thought to be (at least qualitatively) understood at present, and particularly on topics that illustrate the application of physical ideas and reasoning.

The material is examined in two different ways in each chapter: first, the subject of the chapter is discussed qualitatively and conceptually, and then towards the end of the chapter some of the same material is re-analyzed quantitatively using the tools of first year university physics and calculus. The reason for this double approach is connected with the kinds of student who took the one-semester course on "Solar System Physics" that I offered at the University of Western Ontario for a number of years, and for whom this book was written. The course originated as a part of the Astronomy Honours (four-year B. Sc.) programme at the university, and was initially designed around the goals of (a) familiarizing the students with the wide range of aspects of the solar system that can be understood using the material from the first year of university physics, and (b) using the solar system to solidify the students' mastery of that physics. I have found that the solar system provide a wonderful variety of questions that can be discussed using first-year physics, and that a course discussing such problems is very effective at helping students to realize the power of even one year of physics for understanding natural phenomena in their environment.

However, I soon discovered that a number of students other than those in honours physics or astronomy programmes were interested in taking the course. Many of these other students lacked the background in physics needed to solve the problems that formed an important part of our course, and so I developed a second version of the same solar system course, which emphasizes qualitative understanding of concepts, ability to reason with these concepts, and practice explaining basic ideas through a series of essays submitted through the semester. The only prerequisite I imposed for entrance to this more qualitative version of the course was successful completion of any first year university physical science course (astronomy, chemistry, geology, or physics, qualitative or quantitative) so that I could assume that the students would have some prior knowledge of such topics as conservation of energy and the structure of atoms.

Because of limited teaching resources, it was always necessary to teach these two versions of the course together. Thus I have tried to create a single text which could be used by both groups. Descriptive and qualitative material forms the bulk of each chapter; I found that this material could be presented in a manner that is reasonably intelligible to and appropriate for both groups, although students with different backgrounds certainly understand the material in somewhat different ways. The students in the essay version of the course read only these (non-mathematical) sections of the book. To allow the students to test their understanding of the reading as they progress, small exercises are embedded in the text, and review questions are included at the end of each chapter.

To help the students in the problem-solving course to see more clearly how the university physics they have learned may be applied to understanding the solar system, each chapter ends with a section called "Mathematical aspects", in which relevant aspects of first-year physics are reviewed (and perhaps extended), some of the most interesting applications of quantitative physics are discussed, and useful tools for analysis of problems are presented. The students in the problem-solving course read this section, as well as the rest of each chapter. Each chapter has a number of quantitative short exercises in the "Mathematical aspects" section, and students in the problem-solving group are encouraged to do all of these as they come to them. In addition, there is a selection of more challenging problems at the end of each chapter for this group; most of these are conceptually interesting problems rather than the "plug-in" type.

This system of offering two courses in one package has worked quite well, probably because any course on the solar system involves introduction of a very large number of unfamiliar ideas which need to be thought about and discussed qualitatively before they are understood – and before interesting problems can be solved. I have two classes a week for all the students, in which we discuss the big ideas of that week's reading, and a third (tutorial) class for the students in the problem-solving group, devoted mainly to discussion of the use of physics and of problem-solving in the course context. Assignments for the essay course are a series of (usually three) essays on solar system topics, based on the text and supplementary reading. The students in the problem-solving course do a series of problem sets, taken from problems collected at the end of each chapter. Tests and examinations are partly the same for both versions of the course, but the essay course has a number of essay questions on each test which are replaced by short conceptual problems for the problem-solving group.

To encourage the students to learn more about topics of interest, and to help them find suitable subjects for essays, each chapter also includes a short bibliography listing resources that I have found particularly useful. However, since each chapter's bibliography is specific to the subject of the chapter, let me mention a few general solar system texts that may be useful to teachers and students. *The New Solar System* (Cambridge: Cambridge University Press, 1999), edited by A. Chaikin, C. C. Peterson, and J. K. Beatty, provides a good general and qualitative description of the solar system, nicely illustrated with many colour photos. The *Encyclopedia of Astronomy and Astrophysics* (Bristol, U. K: Institute of Physics Publishing, 2001) has many well-written articles at a very suitable level; this encyclopedia is also available at many universities over the Web. W. K. Hamblin and E. H. Christiansen's *Exploring the Planets* (New York, NY: Simon & Schuster, 1995) is a detailed, non-mathematical survey of the geological structure and surface features of the planets in the light of space probe data, with many excellent illustrations. A very good general text on the solar system, with a strong focus on geology, rather less physics, and a little mathematics, is W. K. Hartmann's *Moons and Planets* (Belmont, CA: Wadsworth, 1999). Hartmann's book is perhaps nearest in general level and intention to this book. Finally, there is the much more advanced text *Physics and Chemistry of the Solar System* by J. S. Lewis (San Diego, CA: Academic Press, 1997). Lewis' book contains detailed discussions of many physical, chemical, and geological aspects of the solar system. Parts of that book require a knowledge of vector calculus, partial differential equations, and chemical thermodynamics, but other parts offer very readable reviews covering a wide range of topics. The same general comments apply to *Planetary Sciences* by I. de Pater and J. Lissauer (Cambridge: Cambridge University Press, 2001).

I am grateful to the many people who have helped with the preparation of successive versions of this text over the years. Barbara Landstreet and Anne Brooks typed some of the earlier versions. Tara Sopoco, Sarah Landstreet, and especially Mira Rasche have converted many of the drawings and graphs from rough sketches into clear, handsome illustrations. Successive classes have proof-read the book many times, and offered useful comments. Colleagues, particularly Prof P. Brown, have helped me to find good review material and to understand it. Several anonymous reviewers made extremely helpful and constructive suggestions. I thank all of these people. I am also grateful to the developers of Linux, of the Gnu utilities (especially emacs), of the TEX and LATEX document preparation system, and of the Xmgrace graph tool for the powerful (and free) working environment I have employed to prepare the book. I thank the institutions and individuals from whom I have obtained illustrations, especially NASA with its splendid policy of making all its science images available without copyright restrictions. I am grateful to the many scientists who work in this exciting and fascinating field for their efforts to make their ideas accessible to the rest of us. And finally, I thank my family for encouraging me to persevere with what has at times seemed to be a never-ending project.