Preface

As James Van Allen wrote in his foreword to this book, astronomy permeates our culture. Of all the sciences, astronomy is the one that generates the most public interest. There are hundreds of thousands of amateur astronomers, two monthly astronomy magazines with healthy circulation, and television specials about important astronomical discoveries. The demotion of Pluto from planet to dwarf planet generation headlines and editorials around the world. Part of the public interest in astronomy is surely due to the dramatic scope of the science. Part, I am sure, is because nonprofessionals not only can understand astronomical discoveries but also can make some of those discoveries. Amateur astronomers regularly carry out important astronomical observations, often with telescopes they have made themselves.

The Goals of Astronomy: Journey to the Cosmic Frontier

I wrote this book as a text for an introductory course in astronomy for college students. I have taught such a course for many years at the University of Iowa and the University of Alabama in Huntsville. One of my main goals for those courses, and one of my main goals in this book, is to provide my students with a broad enough, deep enough background in astronomy that they will be able to follow current developments years after they finish my course. This book is current with recent developments such as the cosmological discoveries of the *WMAP* satellite and the results from the Mars rovers. But I want my students to continue to learn about astronomy long after these discoveries have been succeeded by newer, even more exciting, ones. I hope that years from now my students, and the readers of this book, will be able to read and watch stories about astronomy with confidence that they know what is going on and why the story is important. I can guarantee that future astronomical discoveries will occur at least as often as they do today, and I want my students to be prepared to enjoy future discoveries.

I hope that all the explanations and descriptions in the book will not obscure the awe and sense of wonder that all astronomers feel when they pause in their work and think about the beauty of the universe. People have felt that awe since prehistory and our wonderment has increased as we understand more about the order and underlying structure of the universe. If this book helps its readers to value both the sheer beauty of planets, stars, and galaxies and the equally beautiful principles that organize the universe, it will be a success.

I would be grateful for any suggestions and advice for improving this book. If you have any ideas to offer, please contact me at the Department of Physics, University of Alabama in Huntsville, Huntsville, Alabama, 35899, or by e-mail at fixj@uah.edu.

What's New?

Content Updates and Additions As stated, one of the goals of this text is to keep students up to date on current astronomical events and discoveries. In doing so, many new topics have been added to the fifth edition, and several topics from previous editions have been updated. Some of these include:

New Topics

- Sun daggers (Chapter 2)
- ALMA and SKA interferometric arrays (Chapter 6)
- Dwarf planets (Chapter 7)
- Plans for future Moon missions (Chapter 9)
- *Messenger* spacecraft capabilities (Chapter 10)
- Radar detection of buried ice on Mars (Chapter 11)
- The reclassification of Pluto as a dwarf planet (Chapter 13)
- Two new satellites for Pluto (Chapter 13)
- *Cassini* investigation of the icy moons of Saturn (Chapter 14)
- Ice plumes on Enceladus (Chapter 14)
- The *Huygens* landing on Titan (Chapter 14)
- *Deep Impact* projectile impact on Comet Tempel 1 (Chapter 15)
- The discovery of Eris, a dwarf planet larger than Pluto (Chapter 15)
- The Tunguska event in 1908 (Chapter 15)
- Dark matter in the "Bullet Cluster" (Chapter 25)
- Definition of life (Chapter 27)
- Extremophiles (Chapter 27)
- The Drake Equation (Chapter 27)

Updated and Revised Topics

- Temperature structure of Earth's atmosphere (Chapter 8)
- Information on future eclipses (Chapter 9)
- Discoveries by the *Spirit* and *Opportunity* rovers on Mars (Chapter 11)
- More icy bodies beyond Neptune (Chapter 15)
- Solar neutrinos and neutrino oscillations (Chapter 17)
- Magnetars and gamma ray–ray flares (Chapter 20)
- The fraction of stars in binary and multiple systems (Chapter 21)

- Membership of Local Group of Galaxies (Chapter 24 and Appendices)
- High redshift supernovae and the acceleration of expansion (Chapter 26)
- WMAP results (Chapter 26)
- Planets orbiting other stars (Chapter 27)

Additional Planetarium Activities More activities to be integrated with the Starry Night Planetarium software are now available at the end of most chapters.

New and Updated Images Including images from *Hubble, Spitzer, Spirit, Opportunity, Cassini, Huygens,* and *Mars Global Surveyor.*

Pedagogical Feat 6ures

Electronic Media Integration To help better grasp key concepts, this interactive icon has been placed near figures and selections where students can gain additional understanding through the interactives on the *Astronomy* Online Learning Center.

To help better understand key concepts, this animation icon has been placed near figures and sections where students can explore additional information on the *Astronomy* Online Learning Center.

Chapter Introduction Every chapter begins with an introduction designed to give the historical and scientific setting for the chapter material. The overview previews the chapter's contents and what you can expect to learn from reading the chapter. After reading the introduction, browse through the chapter, paying particular attention to the topic headings and illustrations so that you get a feel for the kinds of ideas included within the chapter. Also included in the chapter introduction are questions to explore while reading the text.

Worked Examples Boxes This book, like my course, presumes that many of its readers are not science majors and may not have had a college-level science or mathematics course. The book provides a complete description of current astronomical knowledge, neither at an extremely technical level nor at a level that fails to communicate the quantitative nature of physical science. I have used equations where they are relevant, but follow the equations with boxes containing one or more worked examples. The examples in the boxes show how and when to use each equation and tell why the equation is important.

Historical Emphasis Throughout the book I have emphasized the historical development of astronomy to show that astronomy, like other sciences, advances through the efforts of many scientists and to show how our present ideas developed. In the main body of the text there are many comparisons of what was once known about a particular phenomenon to what we now know about it. These historical comparisons are used to illustrate the cycle of observation, hypothesis, and further observation, which is the essence of the scientific method of discovery.

The epicyclic model perfected by Ptolemy used combinations of circular motions to reproduce the motions of the planets. The model could predict the positions of celestial objects with such accuracy that it was used for nearly 1500 years.

Planetary Data Boxes These boxes include summaries of planetary data making this information easy to access.

Table 12.1 Planetary Data

Jupiter

Orbital distance	5.2 AU
Orbital period	11.9 years
Mass	$318\ M_{Earth} = 1.90 \times 10^{27}$ kg
Diameter	$11.2\ D_{Earth} = 142{,}980$ km
Density (relative to water)	1.33
Escape velocity	60 km/s
Surface gravity	2.54 g
Global temperature	125 K
Main atmospheric gases	H, He
Rotation period	9.9 hours
Axial tilt	3°
Known satellites	63
Distinguishing features	Most massive planet, conspicuous cloud features

Sidereal and Synodic Periods

Equations 4.1 and 4.2 can be used to calculate the synodic period of a planet from its sidereal period or vice versa. Suppose there were a superior planet with a synodic period of 1.5 years. For $S = 1.5$ years and $P_{Earth} = 1$ year, Equation 4.1 is

$$\frac{1}{P} = \frac{1}{(1\ \text{yr})} - \frac{1}{(1.5\ \text{yr})} = \frac{(3-2)}{(3\ \text{yr})} = \frac{1}{(3\ \text{yr})}$$

Thus, P, the sidereal period of the planet, is 3 years. This is the hypothetical planet described in Figure 4.6. As a second example, suppose there were an inferior planet with a sidereal period of 0.25 years. For $P = 0.25$ years and $P_{Earth} = 1$ year, Equation 4.2 is

$$\frac{1}{(0.25\ \text{yr})} = \frac{1}{(1\ \text{yr})} + \frac{1}{S}$$

Rearranging this equation to solve for $1/S$ gives

$$\frac{1}{S} = \frac{1}{(0.25\ \text{yr})} - \frac{1}{(1\ \text{yr})} = \frac{4}{(1\ \text{yr})} - \frac{1}{(1\ \text{yr})} = \frac{3}{(1\ \text{yr})}$$

for which $S = 1/3$ year.

End of Chapter Material

Chapter Summary highlights the key topics of the chapter.

Key Terms listed here are defined in the text and in the end-of-book glossary.

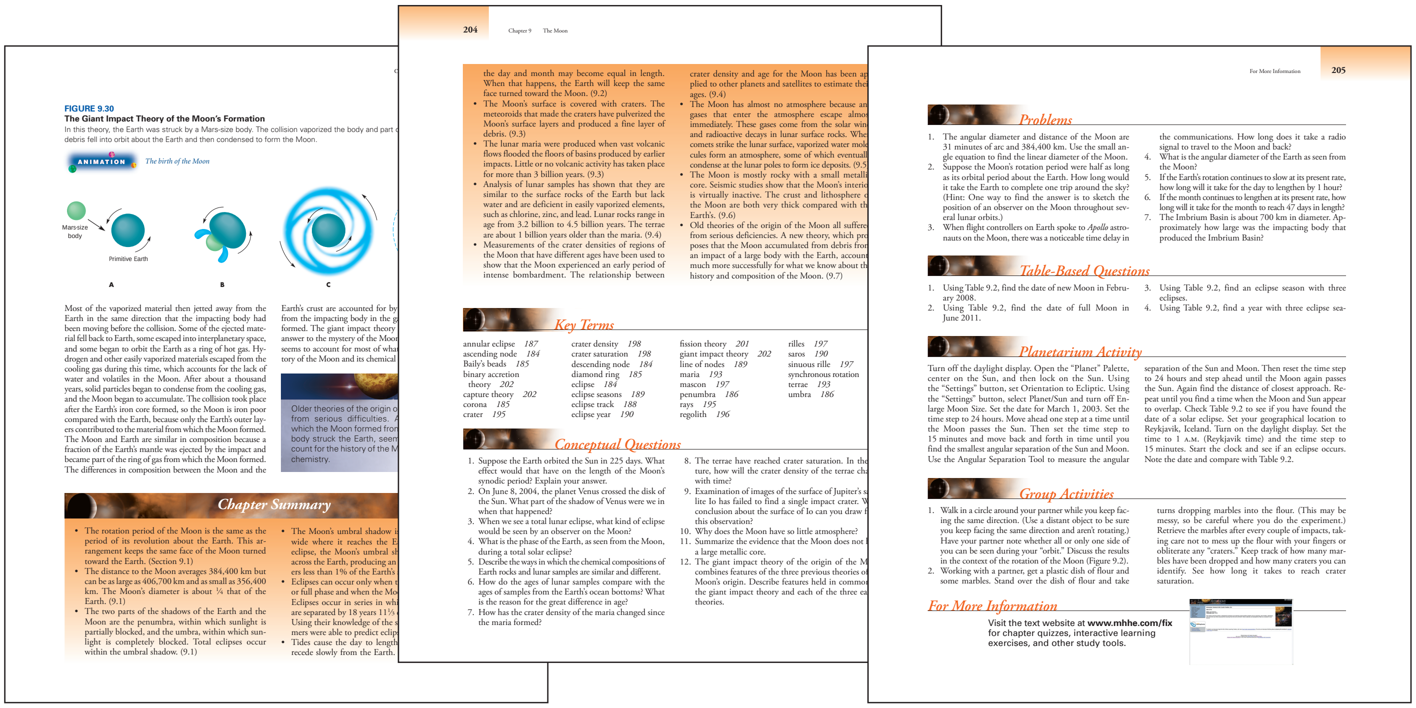
Conceptual Questions require qualitative verbal answers.

Problems, involving numerical calculations, test the reader's mastery of the equations.

Figure-Based Questions require the reader to extract the answer from a particular graph or figure in the chapter.

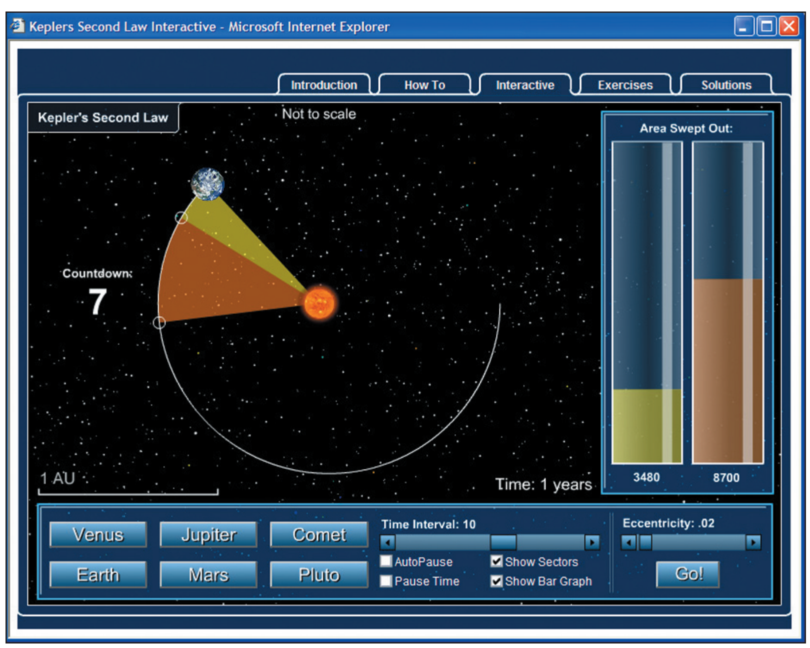
Planetarium Exercises let the reader investigate key ideas of the chapter using the Starry Night planetarium software on the CD that accompanies the book.

Group Exercises encourage interaction between students as they work in groups to discuss different viewpoints on chapter-related issues or to complete small group projects.



End-of-Text Material

At the back of the text you will find appendices that will give you additional background details, charts, and extensive tables. There is also a glossary of all key terms, an index organized alphabetically by subject matter, and constellation maps for reference.



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McGraw-Hill offers various tools and technology products to support *Astronomy: Journey to the Cosmic Frontier, Fifth Edition.* Instructors can obtain teaching aids by calling the Customer Service Department at 800-338-3987 or contacting your local McGraw-Hill sales representative.

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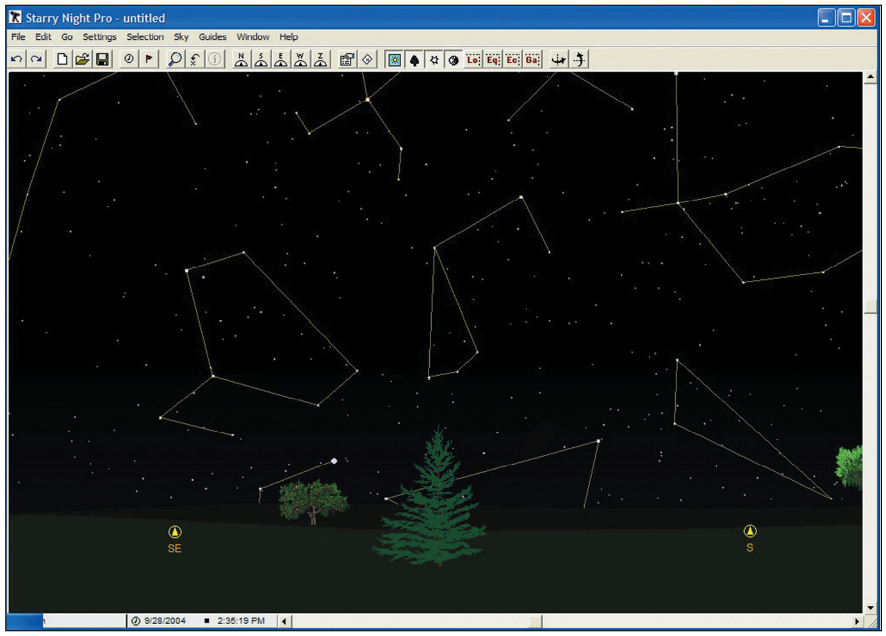
McGraw-Hill is proud to bring you an assortment of 23 outstanding Interactives like no other. Each Interactive is programmed in Flash for a stronger visual appeal. These Interactives offer a fresh and dynamic method to teach the astronomy basics. Each Interactive allows users to manipulate parameters and gain a better understanding of topics such as blackbody radiation, the Bohr model, a solar system builder, retrograde motion, cosmology, and the H-R diagram by watching the effect of these manipulations. Each Interactive includes an analysis tool (interactive model), a tutorial describing its function, content describing its principle themes, related exercises, and solutions to the exercises. Plus, users can jump between these exercises and analysis tools with just the click of the mouse. These Interactives are located on the *Astronomy* Online Learning Center.

Starry Night CD This planetarium software is now available free with every text. It allows users to manipulate and take control of the sky. They become active observers and gain a far better understanding of how the sky works.



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Instructor's Manual The Instructor's Manual is found on the *Astronomy* Online Learning Center (www.mhhe.com/fix) and on the Instructor's Testing and Resource CD, and can be accessed only by instructors.

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Reviewers of Previous Editions

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