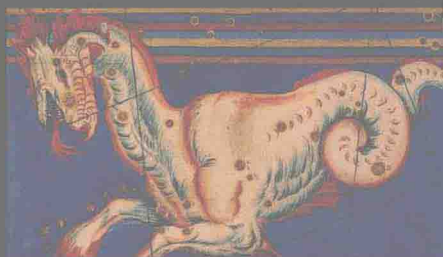


PETERSON FIELD GUIDES

# Stars and Planets



Jay M. Pasachoff/Donald H. Menzel

# A Field Guide to the Stars and Planets

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THIRD EDITION

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JAY M. PASACHOFF  
*Director, Hopkins Observatory  
Williams College*

*This edition succeeds an earlier book by*  
DONALD H. MENZEL  
*Late Director, Harvard College Observatory*

*With Monthly Star Maps and Atlas Charts by*  
WIL TIRION



HOUGHTON MIFFLIN COMPANY

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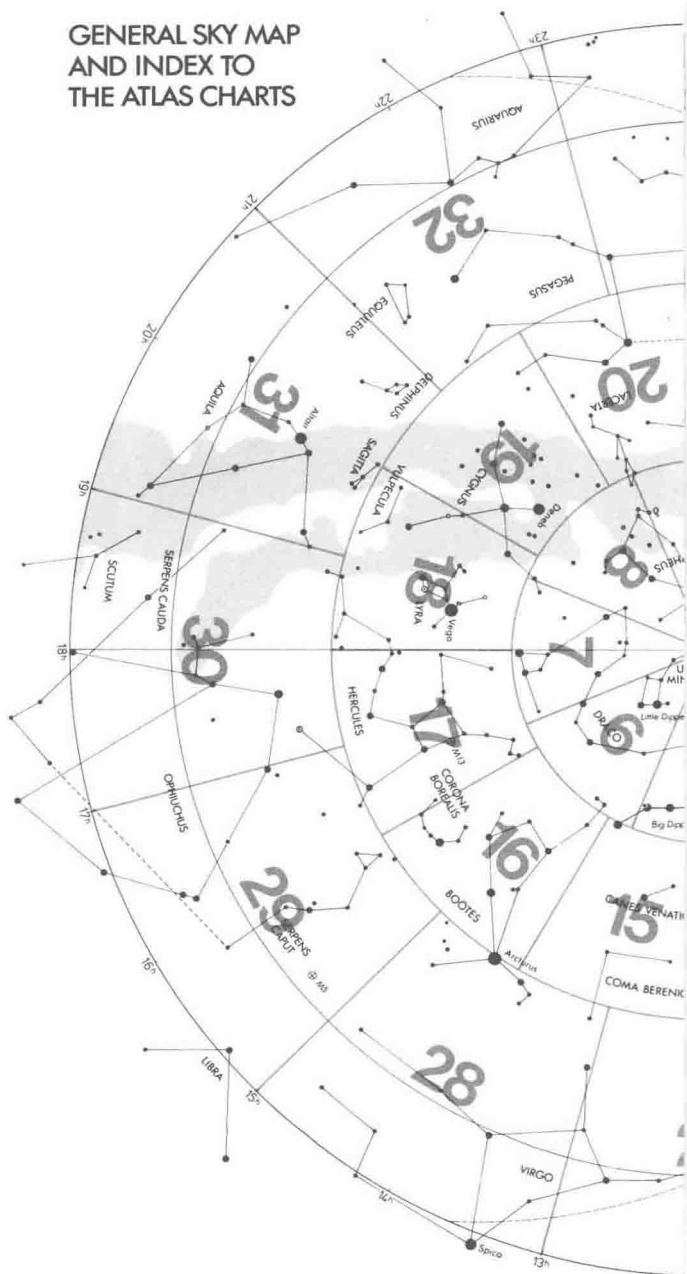
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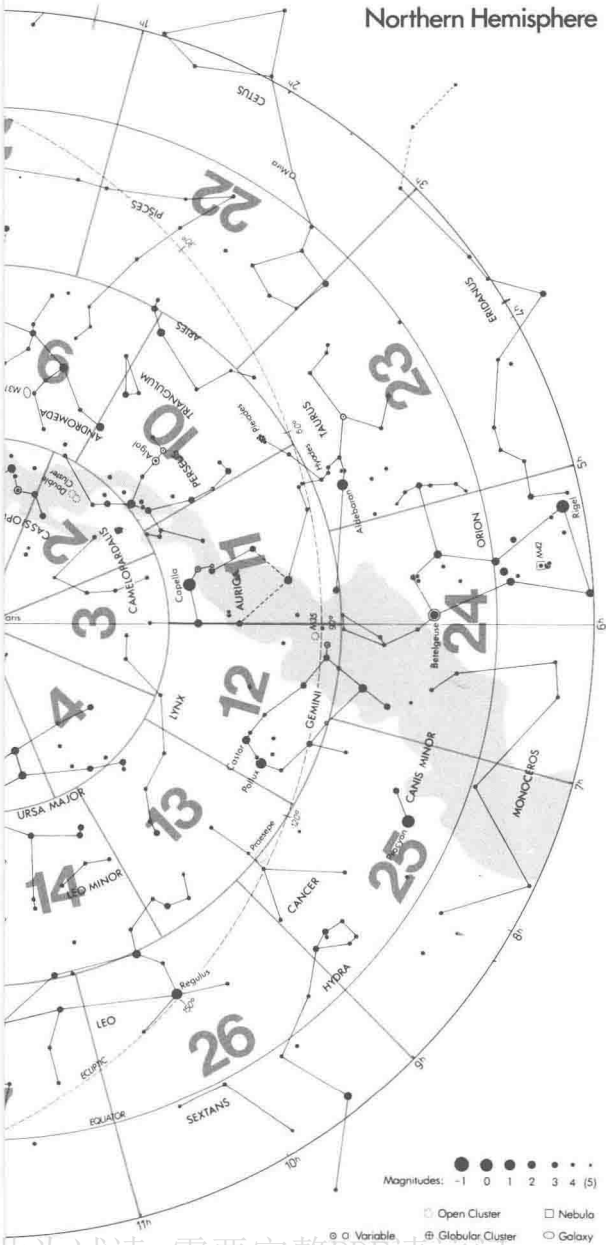
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# GENERAL SKY MAP AND INDEX TO THE ATLAS CHARTS



# Northern Hemisphere



# THE PETERSON FIELD GUIDE SERIES®

*Edited by Roger Tory Peterson*

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Part of the Hercules Cluster of galaxies (National Optical  
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## EDITOR'S NOTE

Although we expect never to publish a guide to the creatures of outer space, it is inevitable that the Field Guide series should include this volume on recognition of the stars and planets.

Among all the inhabitants of the planet earth, we alone have systematically considered the heavenly bodies. We have given names to the constellations and charted their relative positions and movements. Although we formerly believed that we alone were able to navigate by celestial means, now we know that nocturnal bird migrants sometimes take their direction by means of an innate ability to read the night sky and from magnetic fields.

In recent years, in the age of rocket-launched satellites, more people than ever before have become aware of space and want to know what is out there. The tiny dots of light in the night sky may be obscured by city fog, but on clear nights they cannot fail to stir the inquiring mind.

The first step in astronomy, as in zoology, is to put names to things, to identify them. This Field Guide will facilitate the process and is equally usable for the observer depending on the naked eye, the binocular, or a small astronomical telescope. Unlike most of the books in the Field Guide series, which tend to be regional in scope or at least confined to a single continent, it may be used at any point on the earth's surface and on any day of the year. In line with the general policy of the other Field Guides, emphasis has been put on new and simplified techniques of recognition.

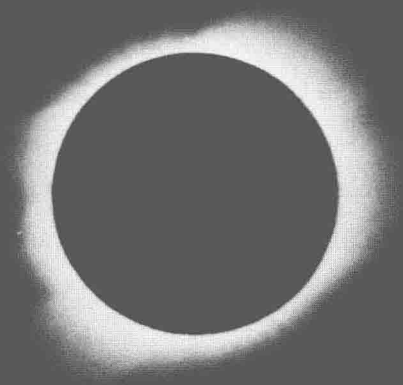
Much has happened in the science of astronomy during the decade since the second edition was issued. Also, techniques and equipment used by amateur astronomers to observe the sky have improved greatly. Further, planets move, double stars move around each other, eclipse series continue, and other celestial events listed in tables in the book change so that new information must be and has been provided. This edition also includes many new color plates.

The book should present no problems to beginners interested in finding their way around in the heavens, but at the same time the completeness of its charts and tables should make it a useful tool for serious amateurs and even for professionals.

It is a joy to thumb through the book while relaxing in an arm-chair, but inasmuch as it is basically a Field Guide, put it to practical use. Use it on clear nights to interpret the free show put on by the heavens.

*Roger Tory Peterson*





The solar corona appears as a pearly white halo around the moon in the few minutes of totality during a total solar eclipse.  
(Jay M. Pasachoff)

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## ACKNOWLEDGMENTS

It is a pleasure in this third edition to enhance the usefulness and beauty of *A Field Guide to the Stars and Planets*. In the book, I present tours of the stars, the planets, the sun, the moon, and other objects in the heavens. It provides introductory descriptions and figures, graphs, and tables of information in a form useful to novices, while providing this and other information in style and quantity useful for those already quite knowledgeable in astronomy. I am very pleased to have had the complete cooperation of the celestial cartographer Wil Tirion. For the second edition, he not only drew a complete set of Atlas Charts covering the whole sky but also prepared monthly star maps to a new design calculated to make them easier to use than previous styles. He also executed supplemental charts for variable stars and other special objects. For this third edition, he added the position of the major supernova that erupted in 1987, improved the shape of the Large Magellanic Clouds, and made other corrections and improvements.

I appreciate the assistance of Cathryn Baskin for her work on the preparation of descriptive material to accompany the Atlas Charts and on other phases of the previous edition of the book. Robert Murphy of Scientia, Inc., has not only prepared his standard Graphic Timetables showing the positions of the planets but also specially designed Graphic Timetables for this Field Guide to show which of the brightest stars, clusters, variable stars, nebulae, and galaxies are suitable for viewing in various seasons. Robert A. Victor of the Abrams Planetarium of Michigan State University expertly prepared descriptive material to accompany the Graphic Timetables. The fruits of Ewen Whitaker's lengthy study of the moon show in the material he has prepared to accompany the moon maps. Robert Argyle of the Royal Greenwich Observatory and Robert Tanguay have provided updates and new information on double stars. I thank them all.

I appreciate the special cooperation of Leif Robinson, William Shawcross, Robert W. Sinnott, Alan Hirshfeld, Dennis di Cicco, and others at *Sky & Telescope*, and thank them for their permission to reprint some of the tables that they have carefully prepared as part of their *Sky Catalogue 2000.0*.

I thank Dennis di Cicco and Ben Mayer for their helpful advice on many phases of observing, for reading large sections of the text, and for the photographs they provided. I also thank Walter Bennett for his verification, with telescopes, of much of the descriptive material that accompanies the Atlas Charts.

Charles Case and the National Geographic Society were kind enough to allow me to use the special moon maps beautifully prepared in a cooperative effort of the National Geographic Society and the U.S. Geological Survey.

I thank many people who assisted with various phases of the preparation of the book, including Naomi Pasachoff for her work on the history and mythology of the constellations, Janet Akyüz Mattei (American Association of Variable Star Observers) for providing information on variable stars, and Ewen Whitaker (Lunar and Planetary Laboratory, University of Arizona) for providing descriptive information and photographs of the moon. I also thank Brian Marsden and Daniel Green (Harvard-Smithsonian Center for Astrophysics) and John Bortle for comments on minor bodies of the solar system, Peter Millman (Herzberg Institute of Astrophysics, National Research Council of Canada) for material on meteor showers, Robert A. Victor (Abrams Planetarium, Michigan State University) for comments on observing, Robert D. Miller for calculations, Jean Meeus for information about eclipses, and George Lovi for information about mapping.

A Field Guide is obviously based on the work of many people carried out over an extended period of time. Users wanting to go beyond this book to do more observing would naturally refer to such magnificent sources as *Sky & Telescope* and *Astronomy* magazines each month, and Robert Burnham's *Celestial Handbook*. Walter Scott Houston's long runs of columns in back issues of *Sky & Telescope* remain a valuable source. We have consulted all these sources in preparation of this Field Guide.

Liz Stell worked expertly and diligently with me in bringing this third edition to publication. Deborah Pasachoff has handled the 1997 update. Susie Kaufman has worked on many matters related to this book. At Houghton Mifflin, Harry Foster is in charge of the Field Guide series. Susan Kunhardt was editor of this third edition; Anne Chalmers was the designer. I also recall with thanks the contributions to the second edition of Barbara Stratton and Cope Cumpston.

My wife, Naomi, and our children, Eloise and Deborah, continue to inspire me. All of them have also helped read proof.

It is a pleasure for me to be associated with my late professor, Donald H. Menzel, in this Field Guide. He had written the first edition; I only regret that he did not live to participate in the entirely new books that we are calling the second and third editions. I learned so much from him on a series of eclipse expeditions, and so much from his example as a scientist dealing with other aspects of astronomy, that I am forever in his debt. I also thank Florence K. Menzel, who with her husband has been kind and helpful to me since my student days. My entire family continues to value Mrs. Menzel as a friend.

I hope that you all enjoy *A Field Guide to the Stars and Planets*. It would be nice if it were error-free, but no book is. I do hope that you will write me with your comments, to point out errors, or with observing suggestions that are not in this book.

Jay M. Pasachoff

Hopkins Observatory, Williams College

Williamstown, Mass. 01267

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## HOW TO USE THIS BOOK

With this *Field Guide to the Stars and Planets* in hand, we hope it will be pleasant for you to find your way around the sky. We have tried to make it easy for you to identify what you see; at the same time, we will try to demonstrate the excitement of our current understanding of the universe.

**General organization.** We begin by describing in Chapter 1 a framework for observing the heavens. We describe how to tell stars from planets, how to identify the brightest stars, and how to find a few of the most prominent groupings of stars in the sky. Then, in Chapter 2, we give you a brief tour around the heavens, season by season. This chapter can be used together with the Monthly Sky Maps that follow in Chapter 3. No special knowledge or equipment is needed to use these maps. For observers in the northern hemisphere, a set of four maps appears for each month: two maps—one with constellation outlines and one without—for use when facing north, and a similar pair for use when facing south. For observers in the southern hemisphere, a set of two maps shows stars with constellation outlines.

Next, in Chapter 4, we describe the constellations and the classical myths associated with them. A list of the current constellations (Appendix 1) appears on p. 440.

In Chapter 5, we describe the types of objects that are relatively constant in their places in the sky, including stars, nebulae, and galaxies. We discuss astronomers' current understanding of these objects, including the stages in the life of a star. We also provide information about the times of year when a selection of the most interesting double and variable stars, star clusters, nebulae, and galaxies are visible. In this chapter, we include spectacular photographs of some of the most beautiful objects. The celestial objects that *move* with respect to the stars—the moon, the sun, the planets, comets, meteors, and asteroids—have their own chapters later on.

Two types of objects of special interest to those observing the sky are double and variable stars, so Chapter 6 is devoted to them. This chapter includes charts and tables that will enable you to find many examples of these stars.

Chapter 7 is an Atlas of the entire sky, broken down into 52 charts, drawn by Wil Tirion. All of the brightest stars and constellations are shown, as on the Monthly Sky Maps; however, the Atlas Charts provide a more detailed look at each region of the sky. Although many

of the objects on the Atlas Charts can be seen with the naked eye or with binoculars, you will find the charts even more interesting if you have access to a small or medium-sized telescope. Each chart shows not only stars but also nebulae, galaxies, and a wide variety of other celestial objects. Descriptions of these objects and photographs of some of them accompany the Atlas Charts. A list of nonstellar, deep-sky objects, the Messier Catalogue, precedes the charts, along with a table showing the region of sky covered by each chart. A visual key to the Atlas Charts appears on the endpapers of this book.

To use the Atlas, first locate an object of interest, using either the Monthly Sky Maps or the celestial coordinates listed in the Messier Catalogue or in other tables in this guide. Then turn to the Atlas Chart where your object is shown. Alternatively, you may choose to survey the whole area shown on a chart with a telescope.

As part of the introduction to the Atlas Charts, we explain the symbols used on the charts and the names used for stars and other types of astronomical objects. We also briefly explain the system of celestial coordinates—right ascension and declination—used to indicate the locations of objects in the sky. The apparent position of objects in the sky changes slightly over the years because the earth wobbles as it spins; we have compensated for this by drawing the charts and calculating the tables in this book for the year 2000, rather than using the 1950 positions most often shown in earlier books.

Though the positions of distant objects in the universe change only slightly in the sky, the positions of the moon, most of the planets, and the sun change quite drastically in the course of the year. The path the sun follows through the sky in the course of a year is called the *ecliptic*; it is indicated by a dotted line on the Monthly Sky Maps and the Atlas Charts. The moon and the planets never stray far from this line.

Chapter 8 describes the moon and includes 10 maps of its craters and other features of its surface. Chapter 9 explains how to locate the planets in the sky and how to predict when they will be visible. Chapter 10 describes what each planet is like and what you may see if you observe it with binoculars or with a telescope.

Chapter 11 describes comets, with special attention to Halley's Comet and its 1985-86 appearance. Chapter 12 discusses meteors and lists meteor showers that you can see in the sky at different times of the year. Meteors usually flash across the sky and asteroids move too slowly for their motion to be apparent. Lights that appear to move slowly and steadily across the sky are usually airplanes or—particularly in the couple of hours after sunset or before sunrise—artificial satellites in orbit around the earth. Chapter 13 discusses asteroids, the minor planets.

In Chapter 14, we turn from the nighttime sky to the daytime sky and discuss the major object that is visible all day—the sun. We discuss not only the everyday sun and how to observe it, but also how to observe at a total solar eclipse and why a total eclipse is so glorious. We also describe annular eclipses, the type in which a ring of sunlight remains, and how to observe them.

Finally, in Chapter 15, we discuss technical aspects of the positions of objects in the sky and ways to tell time by the sun and the stars. We also discuss calendars and their history.

At the end of the book, we present some information on telescopes, a glossary, suggestions for additional reading, an extensive set of tables, and an index.

**Illustrations.** Rendering the sky in a book is a difficult problem because it requires stretching and squashing the curve of the sky onto a flat page. We have solved this problem in a new and improved way in collaboration with our celestial cartographer, Wil Tirion. Our Monthly Sky Maps are presented in a special projection that makes the maps easy to use while distorting the shapes of the constellations as little as possible.

In addition to the 72 Monthly Sky Maps and the 52 Atlas Charts by Wil Tirion, 10 detailed maps of the moon's surface, prepared in a collaborative effort of the National Geographic Society and the U.S. Geological Survey, enhance *A Field Guide to the Stars and Planets*. A number of Graphic Timetables have also been provided to help you determine when stars, planets, and other celestial objects will be visible above the horizon. All photographs in this guide are oriented with north at the top (unless otherwise indicated), to make it easy for you to compare them with the Atlas Charts in Chapter 7.

**Some observing hints.** Your eyes have to be dark-adapted to see the sky well. This process may take 5 to 15 minutes after you go outside from a lighted room. As you watch the sky during this time, more and more stars will become visible. To maintain your adaptation to darkness, cover the front of your flashlight with red plastic.

**Telescopes.** The observing suggestions in this guide are designed to help you locate interesting objects in the sky, whether or not you have a telescope. When we mention a "small telescope" in this guide, we are referring to one with a lens less than 4 in. (10 cm) in diameter. (Most telescopes that small have lenses rather than mirrors.) A "medium-sized telescope" has a lens or mirror about 4-10 in. (10-25 cm) in diameter. For those interested in purchasing a telescope, we include a discussion of some telescopes that are popular with amateurs starting on p. 488, along with a list of telescope manufacturers.

**How to use this book.** If you want to survey the stars and constellations, use Figures 3 and 4 in Chapter 1 and the Monthly Sky Maps in Chapter 3. The seasonal tours in Chapter 2 illustrate how the constellations seem to move across the sky as the earth rotates around the sun. The Graphic Timetable of the Brightest Stars (Fig. 2) in Chapter 1 will show you when the brightest stars visible from mid-northern latitudes will be above the horizon.

If you see a bright object in the sky and want to identify it, the first step is to determine whether it is a star or a planet (see p. 5). Then check the Graphic Timetable of the Brightest Stars in Chapter 1 or the Graphic Timetables of the Planets in Chapter 9, to see which bright stars or planets are visible on your date of observation. Or you can refer to the Monthly Sky Maps in Chapter 3. You can plot the po-



sitions of the brightest planets on the Monthly Sky Maps in Chapter 3 (or on the Atlas Charts in Chapter 7) using Appendix 11, which shows the planets' longitudes along the ecliptic.

If you are using binoculars or a telescope and want to look at a variety of interesting objects, such as double and variable stars, star clusters, nebulae, or galaxies, use the Graphic Timetables in Chapter 5 to find out which ones will be visible on your date of observation. Then turn to the Atlas Charts in Chapter 7, where observing notes supplement detailed charts of each region of the sky. Each chart is oriented with north at the top. Remember that binoculars give a right-side-up image, but most telescopes give inverted images compared with the way celestial objects appear to the naked eye.

If you want to observe the planets with a telescope, refer to the information in Chapter 10.

If you want to see a meteor shower, use the table in Chapter 13.

If you want to know how to observe the sun safely, or when and where the next solar eclipse will occur, refer to Chapter 14.

If you want to know how to tell time by the sun and the stars, refer to Chapter 15.

Some comments on photographing the sky with still cameras or with video cameras appear on pp. 21–23.

So, if you work your way through this book, you will have made friends with the sun in the morning and the stars at night.

Younger readers and other novice observers may enjoy my two brief introductory shirt-pocket-size books, *First Guide to Astronomy* and *First Guide to the Solar System*. Both are in the Peterson First Guide series. Readers wanting more thorough treatments of contemporary astronomy may be interested in my textbook, *Astronomy: From the Earth to the Universe*, which is available for purchase through Hopkins Observatory, Williams College, Williamstown, MA 01267. Send a self-addressed, stamped envelope for information. You can also visit my Web site at <http://www.astro.williams.edu/jay>.