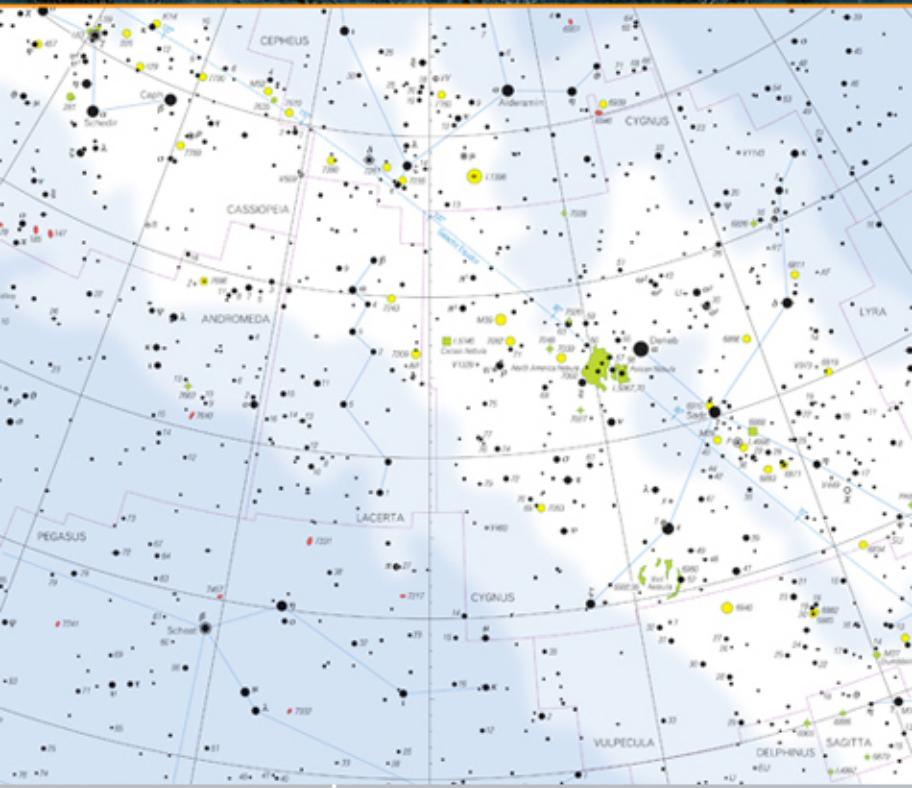
Wil Tirion

# THE CAMBRIDGE STAR ATLAS

Fourth Edition




CAMBRIDGE

more information - www.cambridge.org/9780521173636

## The Cambridge Star Atlas

*The Cambridge Star Atlas* covers the entire sky, both northern and southern latitudes, in an attractive format that is suitable for beginners and experienced astronomical observers. It contains maps of the Moon, a series of seasonal sky maps and a small eight-page atlas showing all of the Messier objects, which also serves as an index to the main Atlas charts; a detailed atlas of the whole sky, arranged in 20 overlapping full-color charts. The charts show stars down to magnitude 6.5, together with about 900 non-stellar objects, such as clusters and galaxies, which can be seen with binoculars or a small telescope. Information about these objects can be found in the tables that accompany the charts.

WIL TIRION is the world's foremost designer of astronomical maps. For this fourth edition he has devised improved versions of all the charts, and the text and star data have been completely revised based on the latest information. Clear, authoritative and easy to use, *The Cambridge Star Atlas* is an ideal reference atlas for sky watchers everywhere.

# THE CAMBRIDGE STAR ATLAS

FOURTH EDITION

WIL TIRION

CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore,
São Paulo, Delhi, Dubai, Tokyo, Mexico City

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by
Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge/9780521173636



First published 1991
Second edition 1996
Reprinted 1998, 1999
Third edition 2001
Reprinted 2004
Reprinted with correction 2005
Reprinted 2007
Fourth edition 2011

Printed in the United Kingdom at the University Press, Cambridge

*A catalog record for this publication is available from the British Library*

*Library of Congress Cataloging in Publication data*

Tirion, Wil, 1943–
Cambridge star atlas / Wil Tirion. – 4th ed.
p. cm.
Includes bibliographical references.
ISBN 978-0-521-17363-6
1. Stars – Atlases. I. Title.
QB65.T537 2000
523.8'022'3–dc21 00–059909

ISBN 978-0-521-17363-6 Paperback

# CONTENTS

## Chapters



## Tables

# PREFACE

Anyone who looks up at the starry sky at night and wonders how to find their way among all those stars will need some kind of sky-guide or atlas, but these must meet very different needs. The casual stargazer will first want to learn what can be seen with the unaided eye: the names of the stars, the constellations and where or when to look for Orion, the Great Bear, or Andromeda. The more advanced observer, with access to a good pair of binoculars or a small telescope, wants to know more: where is the Whirlpool Galaxy, the North America Nebula, or the globular cluster M13?

In 1991 – now twenty years ago – the first edition of *The Cambridge Star Atlas* (originally titled *Cambridge Star Atlas 2000.0)* was published, offering help for both. This twentieth-anniversary edition of *The Cambridge Star Atlas* includes a series of eight seasonal sky maps, designed to be of use for almost anywhere on Earth, and a series of twenty detailed star charts, covering the whole heavens, with all stars visible to the naked eye under good circumstances. These twenty star charts also show a wealth of star clusters, nebulae, and galaxies. Some of these can be seen without optical aids, but for most a small or average-size telescope is needed. Accompanying the charts are tables offering accurate positions and more details of these objects, as well as information about interesting double and variable stars. For this fourth edition all the existing maps have been restyled to give them a more modern appearance.

Preceding the main star charts, you will find a new chapter focusing on the Messier objects; a table and a series of eight star maps (four double-page maps) on which all the Messier objects are plotted on a background showing stars down to magnitude 5.5. These maps also serve as an index to the main star charts.

Probably the most satisfying sight for a beginner using a pair of binoculars or a small telescope is the Moon. As before, *The Cambridge Star Atlas* starts with the Moon, showing the most important features on its surface. Since the Moon is our neighbor in space, and because it is usually the first thing we notice in the night sky, the Moon maps are placed at the beginning, where they belong. The third edition's vector-drawn Moon map has been replaced by more 'realistic' Moon maps, while for observers using a telescope with a star diagonal, a mirror-reversed version has been added on a second spread.

At the end of the atlas you will find a series of six all-sky maps, showing the sky in a special projection, centered on the Galactic Equator. They show the distribution of stars, open and globular clusters, planetary and diffuse nebulae, and galaxies, in relation to our own Milky Way. Finally, a new table lists all of the stars plotted on the main star charts now known to be host to exoplanets.

I do hope you will enjoy this new edition of *The Cambridge Star Atlas.*

Happy stargazing!

*Wil Tirion*

# THE MOON

The Moon is, apart from the Sun, the brightest object in the sky. Although the Sun and the Moon appear almost equal in size, they are quite different. The Sun is the central body of our Solar System, and all planets, including the Earth, orbit around it. The Sun measures 1.4 million kilometers across, and lies at a distance of roughly 150,000,000 kilometers. The Moon is much smaller and measures 'only' 3,476 kilometers across; approximately one quarter of the Earth's diameter. The Moon lies at an average distance of 384,400 kilometers from the Earth. It orbits, not the Sun, but our own planet, in a little more than 27 days.

Although we often refer to the Moon as 'shining' it does not of itself give any light. It only reflects the light it receives from the Sun. This is the reason why the appearance of the Moon changes as it orbits the Earth. This aspect of the Moon, sometimes visible as a thin crescent in the western sky, after sunset, and sometimes as a full disk, lightening up the middle of the night, is confusing to many people. The reason for this can be best explained in a diagram (figure 1).

The illustration is not drawn to scale, but shows you what happens. The Earth is at the center and the Moon's orbit is drawn as a circle. During its orbit around the Earth we see a different portion of the illuminated side of the Moon's surface. (In the figure the red arrows indicate our line of sight from the Earth.)

When the Moon is approximately between the Sun and the Earth, we see only its dark side. We call this a new Moon. The Moon is not visible at all. After one or two days we see a small crescent in the evening sky; a part of the illuminated side is peeping around the edge. After almost a week, half of the disk is lit and we call this the first quarter. Another week later we see the complete disk. This is a full Moon. Next comes the last quarter, and then back to new Moon again. From one new Moon to the next takes about 29.5 days, fully two days longer than it takes the Moon to orbit the Earth. The reason for this is that, in the time the Moon revolves around

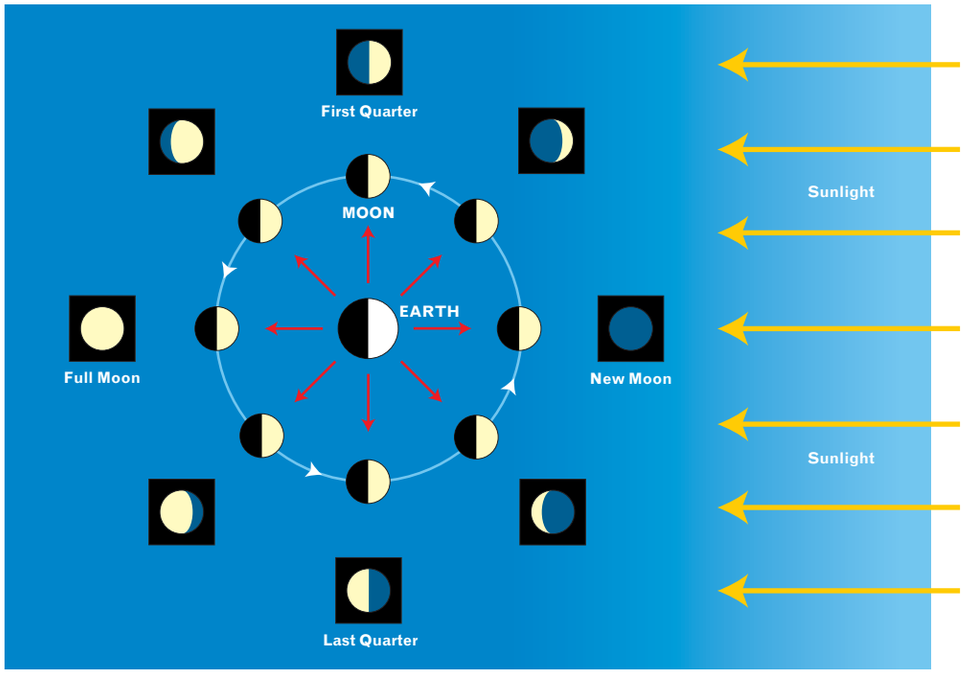



**Figure 1**

the Earth, the Earth also moves in its orbit around the Sun. In the 27 days it takes the Moon to orbit the Earth, the Sun's position in the sky also changes, moving in the same direction the Moon moves. It takes the Moon more than two days to 'catch up' with the Sun.

## Observing the Moon

Even with a simple pair of binoculars you can see interesting features on the Moon's surface, and a small telescope will reveal even more details of our neighbor in space. The best time to watch the Moon is not when it is full, but rather around its first or last quarter. Then the Moon is illuminated by the Sun from one side and especially near the terminator, the line dividing the lit and the unlit halves of the Moon, there is strong relief, because the surface is illuminated from a very low angle, resulting in long shadows. At full Moon you do not see any relief, since you are then looking from approximately the same direction as the Sun's rays come from. But full Moon is an ideal time to study the differences between the dark and light areas of the surface.

On the Moon maps (on pages 4–5 and 6–7), you can identify the craters and other small features, by referring to the numbers in the list alongside the maps. To help you see which crater a number is referring to, a small black dot is placed in its center. On the first double-page Moon map (map A) the features are listed in numerical order, and for your convenience they are repeated in alphabetical order on the second spread, with the mirror-reversed map (map B). The reason the Moon is shown in two different ways is explained below and on page 3.

Larger features, like mountain ranges and the darker areas called *maria,* are labeled directly on the map. *Maria* is the plural form of the Latin word *mare*, meaning sea. The first observers who believed that these dark areas on the Moon really were seas gave the name. Although we now know there are no seas on the Moon, the name persists, as also do the names *lacus* (lake) and *oceanus* (ocean).

Most craters on the Moon are believed to be the result of the impact of meteors: pieces of rock and metal from space. The Earth is well protected against the impact of meteors by the atmosphere, which causes meteors to burn and vaporize. We call that a 'falling star' or 'shooting star', though it is not a star at all. Only fragments of large meteors reach the surface; we call these fragments meteorites. But the Moon does not have an atmosphere, so every meteor captured by the Moon's gravity will crash into the surface.

Because the Moon rotates 360° on its axis in exactly the same time that it takes to complete one orbit around the Earth, we always see the same side of the Moon. However the Moon's orbit is inclined about 5° to the *ecliptic* (page 37), making it move slightly above and below the plane of the Earth's orbit around the Sun, and the Moon's own spin axis is also tilted about 1.5°. The combined result is that we can occasionally see about 6.5° 'over' the North and South Poles of the Moon. Moreover, since the Moon's orbit is not really a circle, but an ellipse, it does not move at a constant speed, though its rotation speed remains the same. Thus, as seen from the Earth, it moves a little from left to right, as if it were shaking its head very slowly. Therefore, we can look around the edges, by up to 7°. Sometimes Mare Crisium (in the northeastern quadrant of the Moon) appears very close to the edge, and sometimes it is closer to the center, and has a less elliptical appearance. The elliptical appearance of Mare Crisium, as well as those of craters close to the visible edge, is of course caused by perspective.

## Different orientations of the Moon

Naked-eye observers living in the northern hemisphere see the Moon with north up and south down. That is also the way they will see it in a pair of binoculars. However, using an astronomical telescope will usually show the Moon 'upside down'. That is why map A, on pages 4–5, shows the Moon with south at the top, so that will be practical for most observers using a telescope. For naked-eye or binocular observations the map has to be held upside down.

When you are living in the southern hemisphere, it will be the other way around. The map can be used directly for naked-eye and binocular observations, but when you use a telescope, you have to rotate