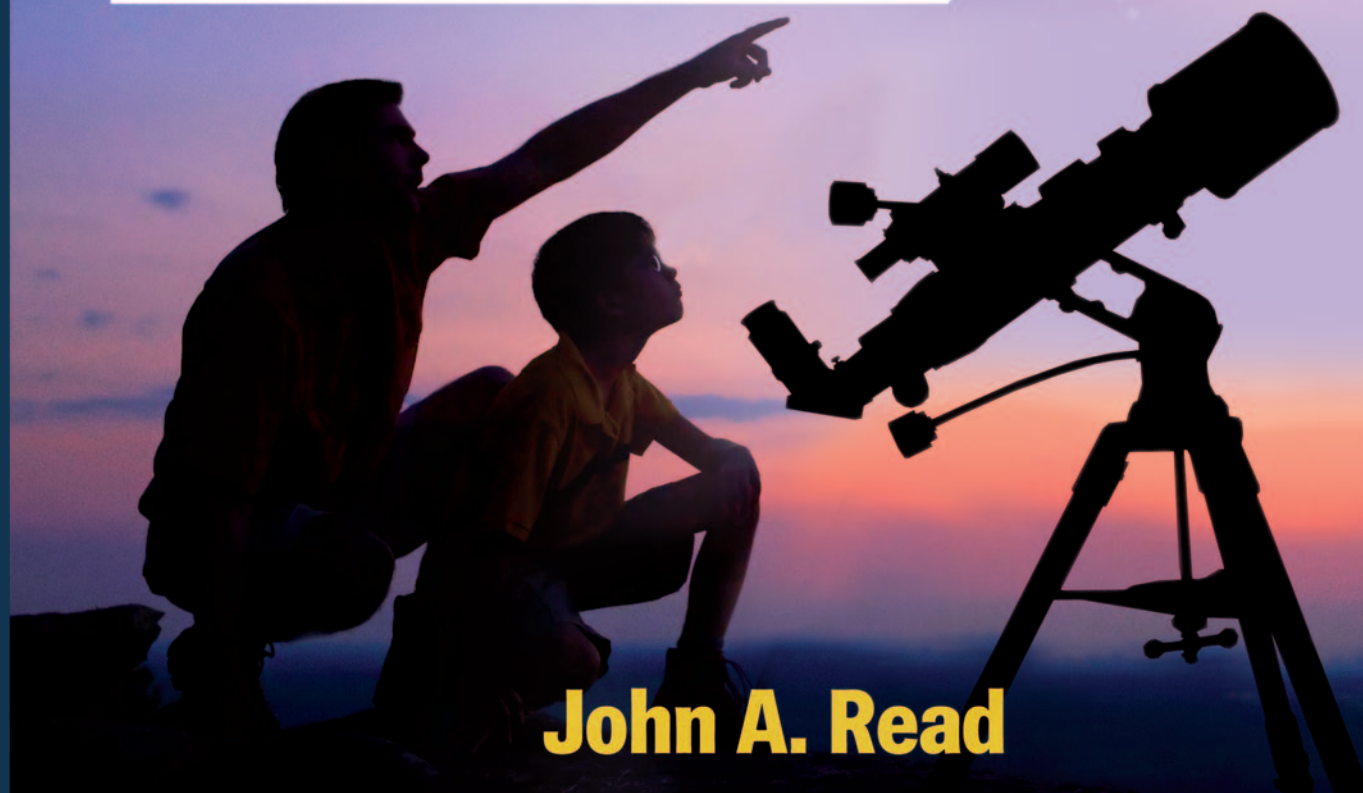


# **50** THINGS TO SEE **WITH A** TELESCOPE

**A YOUNG STARGAZER'S GUIDE**



**John A. Read**





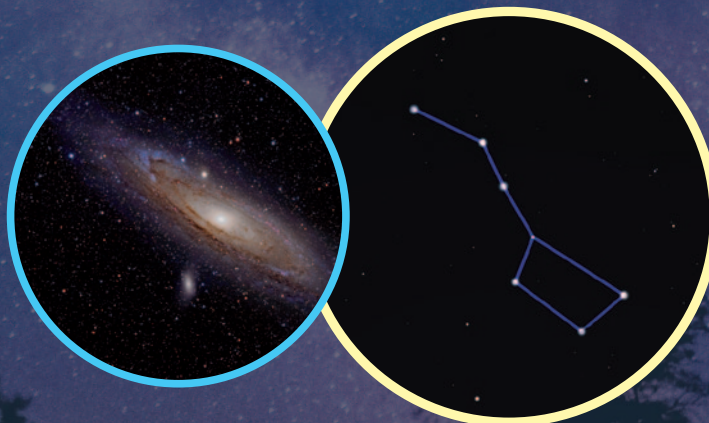
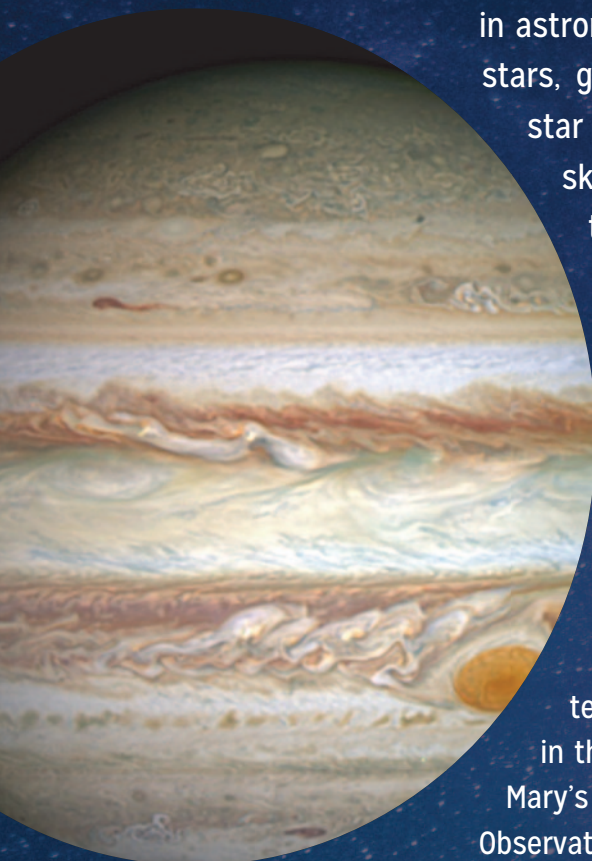
# A BEGINNER'S GUIDE TO THE NIGHT SKY

This book explains everything you need to jumpstart your journey in astronomy. You will learn how to identify constellations, planets, stars, galaxies, nebulae and more. Inquisitive stargazers will find star hopping easy with clearly plotted routes. And images of the sky both as seen by the naked eye and detailed views from a telescope will aid in your exploration.

Many fascinating cosmic objects can be easily spotted with the help of this book including beautiful constellations Cassiopeia and Leo, the plentiful Kemble's Cascade, the explosive Crab Nebula and the rings of Saturn!

This easy to read, illustrated reference book will enrich every young person's experience of the skies above.

**JOHN A. READ** volunteered at hundreds of stargazing events as a member of the Mount Diablo Astronomical Society in California, teaching people of all ages how to use a telescope and find objects in the sky. He is now back in Canada studying astrophysics at Saint Mary's University. John is a telescope operator at the Burke-Gaffney Observatory, and a board member at the Halifax Centre of the Royal Astronomical Society of Canada. He lives in Halifax, Nova Scotia.



ISBN-10: 1-4595-0536-0  
ISBN-13: 978-1-4595-0536-0



9 781459 505360

**FORMAC**  
PUBLISHING COMPANY LIMITED  
WWW.FORMAC.CA

# **50 THINGS TO SEE WITH A TELESCOPE**

**A YOUNG STARGAZER'S GUIDE**

**John A. Read**

**Formac Publishing Company Limited  
Halifax**



# *For my boys, Isaac and Oliver.*

Text Copyright © 2018 John A. Read

Published in Canada in 2018.

This edition published in the United States in 2019.

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, or by any information storage or retrieval system, without permission in writing from the publisher.

Formac Publishing Company Limited recognizes the support of the Province of Nova Scotia through the Department of Communities, Culture and Heritage. We are pleased to work in partnership with the Province of Nova Scotia to develop and promote our cultural resources for all Nova Scotians. We acknowledge the support of the Canada Council for the Arts, which last year invested \$153 million to bring the arts to Canadians throughout the country. This project has been made possible in part by the Government of Canada.



Cover design: Tyler Cleroux

Cover image: Istock

Library and Archives Canada Cataloguing in Publication

Read, John A., author

50 things to see with a telescope : a young stargazer's guide /

John A. Read.

-- New edition.

ISBN 978-1-4595-0536-0 (hardcover)

1. Astronomy--Observers' manuals--Juvenile literature. 2. Astronomy--Amateurs' manuals--Juvenile literature. 3. Telescopes--Amateurs' manuals--Juvenile literature. I. Title. II. Title: Fifty things to see with a telescope.

QB63.R395 2018 j520 C2018-903014-3

Published by:	Distributed in Canada by:	Distributed in the US by:
Formac Publishing	Formac Lorimer Books	Lerner Publisher Services
Company Limited	5502 Atlantic Street	1251 Washington Ave. N.
5502 Atlantic Street	Halifax, NS, Canada	Minneapolis, MN, USA
Halifax, NS, Canada	B3H 1G4	55401
B3H 1G4		www.lernerbooks.com
www.formac.ca		

Printed and bound in Canada.

Manufactured by Friesens Corporation in Altona, Manitoba, Canada in July 2018.

Job # 245950

This digital edition first published in 2018 as 978-1-4595-0537-7

Originally published in 2018 as 978-1-4595-0536-0

## **ACKNOWLEDGEMENTS**

Special thanks to my editors Kurtis Anstey, Kara Turner, Jennifer Read and David M.F. Chapman. Thank you to everyone at Formac for your excellent collaboration on this project.

## **PHOTO CREDITS**

Telescope view source files for deep-sky objects were constructed from actual photos taken by the author, either using his personal four-inch refractor, twelve-inch Dobsonian and eight-inch Dobsonian, or using the following remote observatories: Abbey Ridge Observatory (owned by Dave Lane), and the Burke-Gaffney Observatory at Saint Mary's University, Halifax. Exceptions include M1, imaged by Kurtis Anstey; Comet C/2013 US10, imaged by Dave Lane; and M81, M82, and the Double Cluster, by Stuart Forman.

Other images used include: images from NASA which follow NASA's photo usage guidelines; image of Comet 67P/Churyumov Gerasimenko from ESA/Rosetta/NAVCAM, CC BY-SA IGO 3.0; image of Celestron FirstScope Dobsonian compliments of Celestron; image of Explore Scientific FirstLight refractor compliments of Explore Scientific; image of Andromeda on back cover by Adam Evans courtesy of Wikimedia; background images in interior from Shutterstock.

Star maps used in this book were sourced using Stellarium, an open-source stargazing program. These maps were then customized for the purpose of this book. Several of artist Johan Meuris constellation images from Stellarium are included in this book and usage rights can be found here: [artlibre.org/licence/lal/en/](http://artlibre.org/licence/lal/en/).



# TABLE OF CONTENTS

Using This Book .....	4
The Sky Above Us .....	6
Dark Skies .....	8
Seasonal Skies .....	9
Choosing a Telescope .....	10
Parts of a Telescope .....	11
Getting Started .....	12
Star Hopping .....	14

<b>CHAPTER 1 YEAR-ROUND OBJECTS .....</b>	<b>15</b>
01 The Moon .....	16
02 The Big Dipper & The Surfboard Galaxy ...	18
03 Mizar & Alcor .....	19
04 The Whirlpool & Pinwheel Galaxies .....	20
05 The North Star (Polaris) .....	21
06 The Little Dipper & Bode's Nebula .....	22
07 The Big W & Cluster M103 .....	23
08 The Dragonfly (NGC 457) .....	24
09 Kemble's Cascade .....	25

<b>CHAPTER 2 WINTER OBJECTS .....</b>	<b>26</b>
10 Orion (The Hunter) .....	27
11 The Orion Nebula (M42) .....	28
12 The Twins (Gemini) & Cluster M35 .....	29
13 Canis Major & Cluster M41 .....	30
14 The Crab Nebula (M1) .....	31
15 The Hyades (in Taurus) .....	32
16 The Pleiades (M45) .....	33
17 The Starfish Cluster & The Cloaking Warbird ...	34
18 Perseus & Spiral Cluster M34 .....	35
19 The Winter Hexagon & The Satellite Cluster ..	36

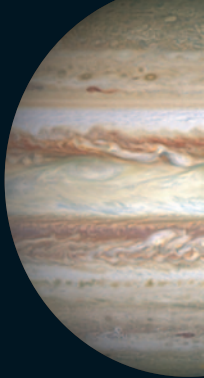
<b>CHAPTER 3 SPRING OBJECTS .....</b>	<b>37</b>
20 Corona Borealis & Cluster M5 .....	38
21 Boötes & Cluster M3 .....	39
22 The Diamond & The Sombrero Galaxy .....	40
23 Leo & The Hamburger Galaxy (NGC 3628) .....	41
24 Cancer & The Beehive .....	42

<b>CHAPTER 4 SUMMER OBJECTS .....</b>	<b>43</b>
25 Scorpius & Cluster M4 .....	44
26 The Omega Nebula & Ptolemy's Cluster ...	45
27 Cluster M22 & The Butterfly (M6) .....	46
28 Clusters M10 & M12 in Ophiuchus .....	47
29 The Wild Duck Cluster (M11) in Aquila .....	48
30 The Eagle Nebula (M16) .....	49
31 The Ring Nebula (M57) in Lyra .....	50
32 The Northern Cross, Albireo & Cluster M56 ...	51
33 The Summer Triangle & Cluster M71 .....	52
34 The Dumbbell Nebula (M27) .....	53
35 The Coathanger .....	54
36 Cluster M13 in Hercules .....	55
37 The Summer Beehive .....	56

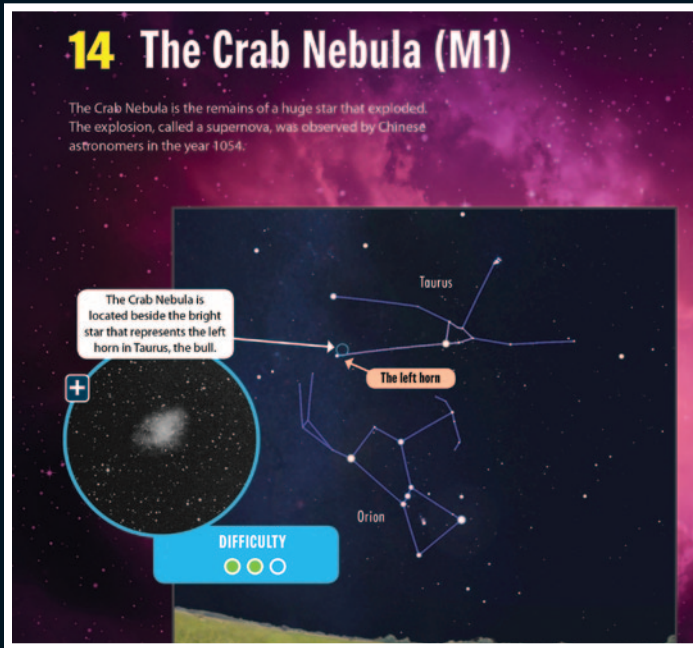
<b>CHAPTER 5 AUTUMN OBJECTS .....</b>	<b>57</b>
38 The Triangulum Galaxy in Pegasus .....	58
39 The Andromeda Galaxy .....	59
40 The Double Cluster .....	60
41 The Iris Nebula in Cepheus .....	61

<b>CHAPTER 6 OTHER OBJECTS .....</b>	<b>62</b>
42 Mercury .....	63
43 Venus .....	64
44 Mars .....	65
45 Jupiter .....	66
46 The Galilean Moons .....	67
47 Saturn .....	68
48 Uranus .....	69
49 Neptune .....	70
50 Comets .....	71

Glossary .....	72
----------------	----



# Using This Book



This book is designed as an introduction to stargazing. Most sections introduce a star pattern (a constellation or asterism) that can be identified without a telescope, with arrows directing you to the telescope targets within that part of the sky.

The little blue circle on the map represents an estimation of how much sky you might see through your telescope.

These round windows on nearly every page show how the object will look through your telescope in perfectly dark skies. Note: galaxies and nebulae (giant clouds of gas and dust) will require extremely dark skies to appear as they do in these images.





If you see this symbol, the object can be viewed with binoculars.



Planets (items 42–49) appear to wander through the ecliptic (the path the Sun travels across the sky) and require software to locate on any given night. The stargazing software “Stellarium” is free and can be downloaded at [www.Stellarium.org](http://www.Stellarium.org) or from the app store.



**DIFFICULTY**



Attached to each telescope view window is a measure of how challenging an object is to observe. Level 1 can be found with ease (assuming the object is above the horizon). Level 2 requires some patience, while level 3 requires extremely dark skies or, in the case of Uranus and Neptune, the use of stargazing software.



# The Sky Above Us

Humans have gazed up at the sky since before the dawn of civilization. The movements of the Sun and planets along with the fixed positions of the stars helped people know when to plant their crops and how to navigate the seas.

Nearly every culture on Earth grouped stars into patterns and gave them names. The Greeks named one group Orion the Hunter. Meanwhile, Chinese astronomers included the same stars as two of 28 Mansions. Hindi astronomers called these stars the Deer. The most popular star pattern, which we today recognize as the Big Dipper, has had dozens, if not hundreds of names throughout history. The Inuit people of what is now northern Canada at one point called it *Tukturjuik*, the Caribou. In eastern Europe, it was called the Great Wagon, while Arabian societies viewed these stars as a coffin.



The Caribou



Greater Bear

## Stellar Facts

Constellations are names astronomers have assigned for regions of the sky based on patterns of stars. Most of the constellation names we use today were named by the ancient Greeks, while the stars' names are mostly Arabic in origin.

## Stellar Facts

A star pattern within a constellation is called an asterism. Asterisms have common names like the Big Dipper, the Diamond or the Teapot.



## Island universes

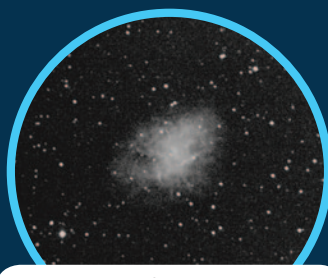
We live within a collection of stars called the Milky Way Galaxy. Up until the early 1900s, many astronomers thought the Milky Way (which contains about 300 billion stars) was the entire universe. Although other galaxies could be seen through almost any telescope, scientists did not know how distant they were, assuming they were clouds of gas within our galaxy. But in 1920, an astronomer named Heber Curtis argued otherwise, calling these objects “island universes.” In 1923, Edwin Hubble proved Curtis right, calculating the distance to the Andromeda Galaxy and many others, proving once and for all that these nebulae were not nebulae at all, but individual galaxies each containing billions of stars.

## Objects that are not comets

A French comet hunter named Charles Messier created a list of 110 fuzzy objects he saw through his telescope. Messier didn’t know what they were at the time, but he could tell that they weren’t comets. We now know the following as deep-sky objects: open star clusters, globular star clusters, nebulae and galaxies. The objects are named according to Messier’s initial “M” and their number in this catalogue. Messier’s list is now the primary target list for amateur astronomers. Most deep-sky objects mentioned in this book are included in Messier’s list.



M31 – The  
Andromeda  
Galaxy



M1 – The first object in  
Messier’s list of objects  
that aren’t comets



M103 – Open  
Cluster



M20 – Trifid Nebula

# Dark Skies

The objects in this book can be located in the night sky in the northern hemisphere as long as it is the correct season and the sky is clear. However, some galaxies, nebulae and globular clusters require dark or very dark skies. How dark are your skies? Use the images below as a guide.

## POOR SKY

In a town, or during a full moon.

## FAIR SKY

Suburban skies, 10 kilometres from the nearest town..

## DARK SKY

Country skies, 20 kilometres from the nearest town.

## VERY DARK SKY

50 kilometres from the nearest town



The Whirlpool Galaxy (M51) viewed under different sky conditions

Each blob in this image from the Hubble Space Telescope is a galaxy containing hundreds of billions of stars.

## How many stars can you see?

Though a telescope, you're able to see millions of stars. Without a telescope, there are fewer than 10,000 stars visible, and only about 2,500 are visible at any one time. Near a town, or when the moon is full, you'll only be able to see a few hundred stars.

In a city, you might only see a dozen! How many stars are there in the observable universe? We can estimate by multiplying the average number of stars in a galaxy by the number of visible galaxies. The total is about one septillion stars (1,000,000,000,000,000,000,000,000), although astronomers believe the actual number is much higher than this.



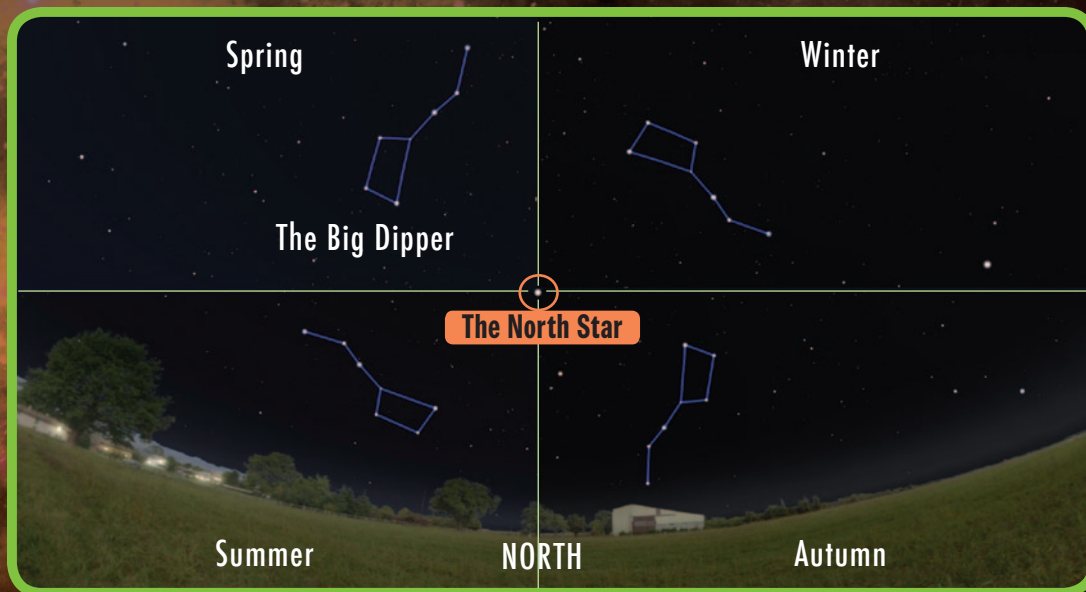


# Seasonal Skies

Hopefully you know that Earth revolves around the Sun. This fact has a fascinating consequence in astronomy. As Earth orbits the Sun, the nighttime side faces a different part of the sky — the stars overhead at night in the winter are overhead during the day in summer. For this reason, the constellations and targets in this book are ordered by season.

Not all stars rise and set. Many stars in the northern sky can be seen all year from the northern hemisphere. (If you are south of the equator — in Australia, for example — it's the southern stars that do not rise and set.) When you look up at the night sky for any length of time, you'll notice that the stars appear to rotate around the North Star. A complete rotation occurs about once every day, as Earth spins, and about once every year, as Earth revolves around the Sun.

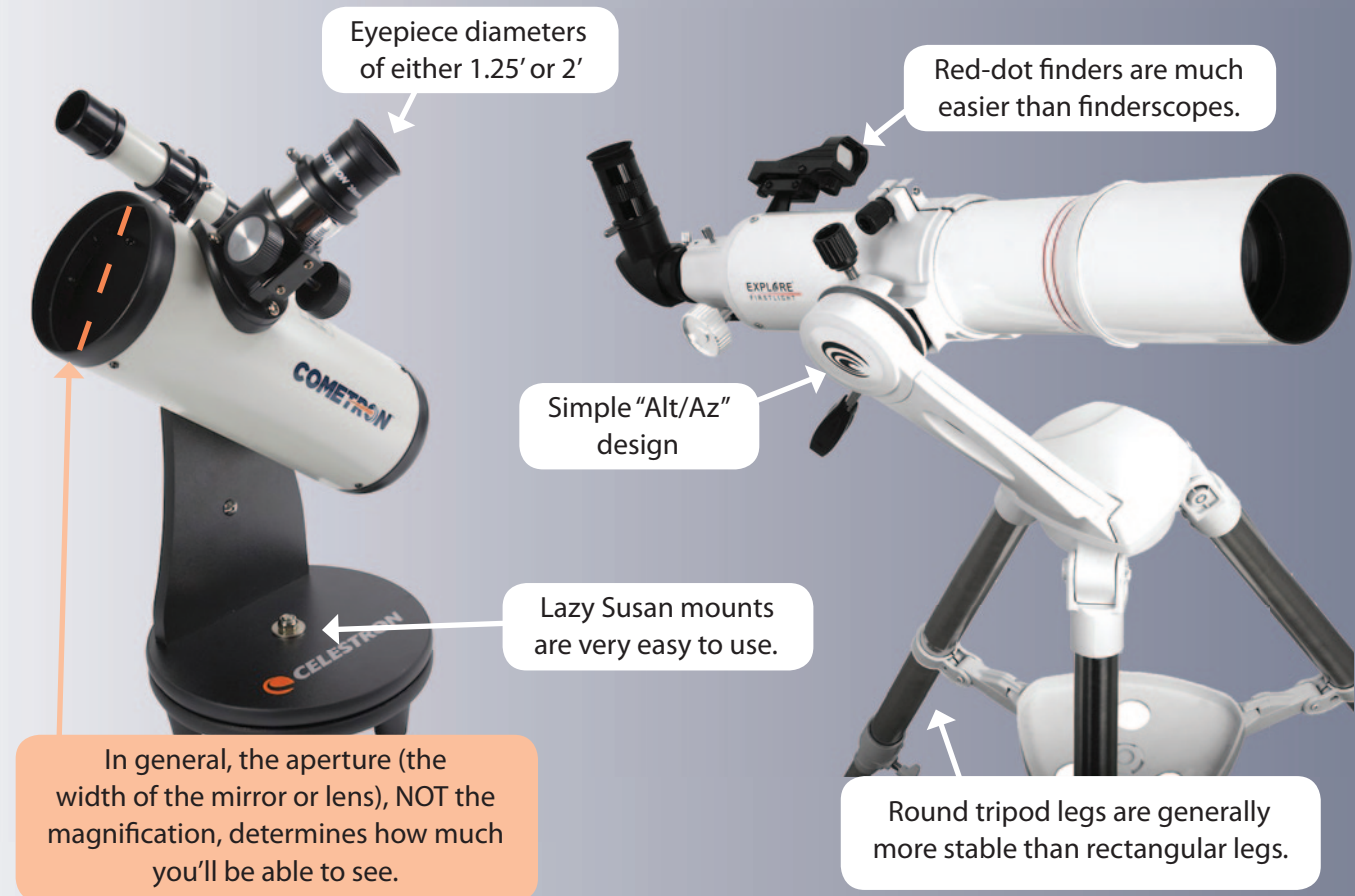
Objects in the night sky that never rise or set but appear to circle the North Star are referred to as "circumpolar." We'll explore many of these objects in Chapter 1.



# Choosing a Telescope

Amateur astronomy is a challenging hobby, even for an adult. The targets in this book are beyond the range of toy telescopes. In general, the best telescopes for beginners are either Dobsonians or refractors on solid alt/az (up/down–left/right) mounts. Here are a few things you'll want to look for in a telescope:

Avoid telescopes on flimsy or camera tripods. These telescopes may be marketed to kids, but they are extremely challenging to point at objects in space.

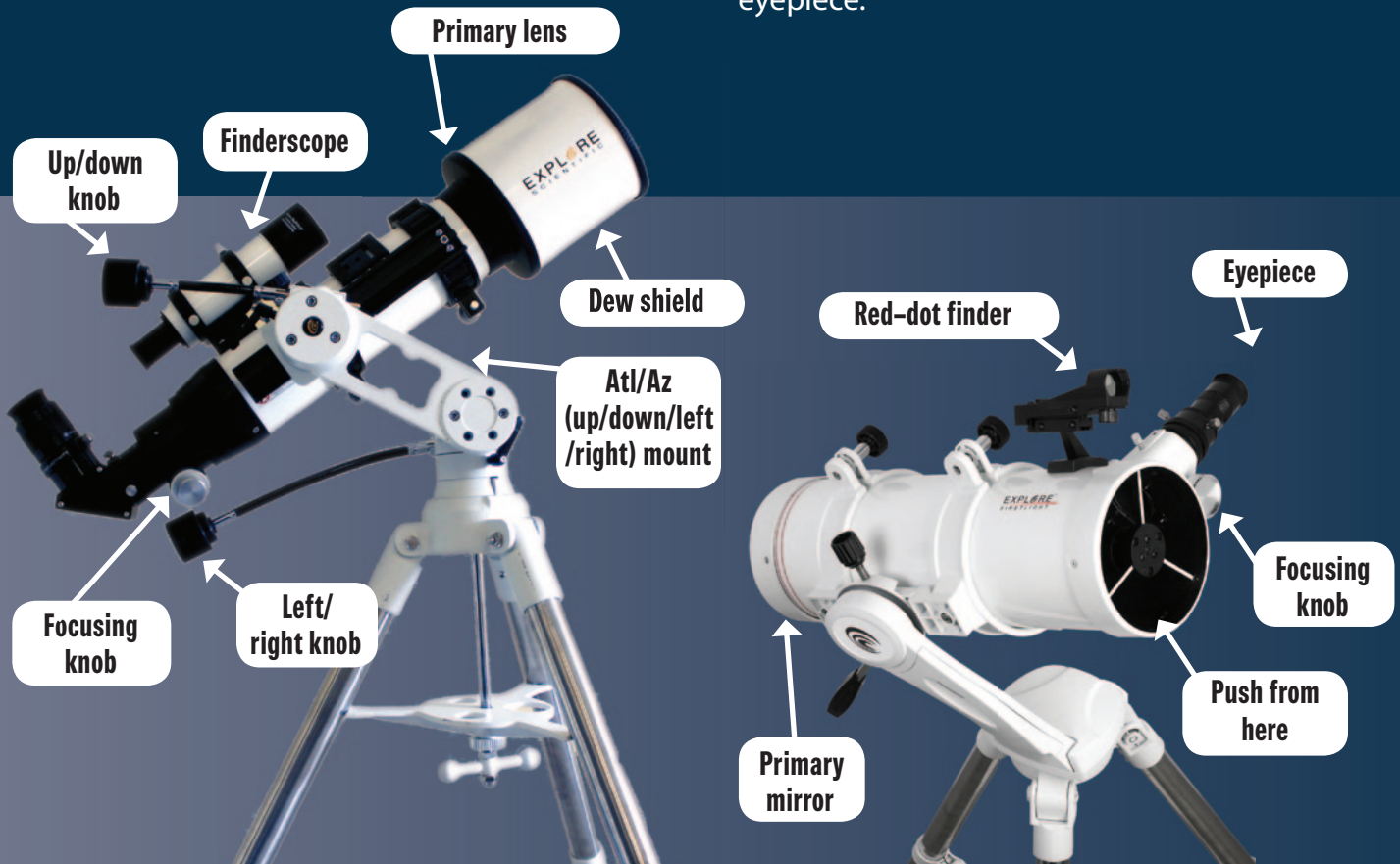




# Parts of a Telescope

Refractors, like the telescope on the left, use lenses to magnify distant objects.

Reflectors, like the Newtonian telescope on the right, use mirrors to direct light into the eyepiece.



Equatorially mounted (EQ) telescopes (not shown) are designed to track the Earth's rotation along a single tilted axis. They have additional features that can be challenging for young kids.

# Getting Started

## Setting up your telescope

When you set up your telescope, be sure to follow the manual closely or find a video online specific to your telescope, and follow the instructions. Try to set up your telescope on solid, level ground and not a deck. Vibrations from walking on the deck will travel through the telescope and make the image bounce. It's important to have a clear view of most of the sky unobstructed by trees or buildings and away from artificial sources of light.

Once you have the telescope assembled, make sure it is working properly by testing to see if it can point in all directions. Ensure the telescope and mount stays in place when you let go.

## Choosing an eyepiece

Most beginner telescopes come with two eyepieces, one with a larger lens (more glass) than the other. The eyepiece with the larger lens is the one you want to use most of the time. Only use the smaller one when you want to zoom in on a target like a planet. You'll find you won't need to zoom in very often because the most important thing is light gathering, not magnification.

Many telescopes come with a lens called a "3x Barlow" or "2x Barlow." These devices are designed to be placed between the eyepiece and the telescope to triple or double the magnification. However, this also makes your telescope much more difficult to aim and focus, and most of the time the Barlow attachment is unnecessary.



Barlow lens (use sparingly)



Large eyepiece (left) and small eyepiece (right)  
(Ideally use the larger one)



A filter may also have been included with your telescope. Filters thread into the bottom of the eyepiece before the eyepiece is set into the telescope. The filter, which may be labelled “Moon” or “Polarized” is designed to reduce brightness and see more details when observing the Moon.

## Focusing your telescope

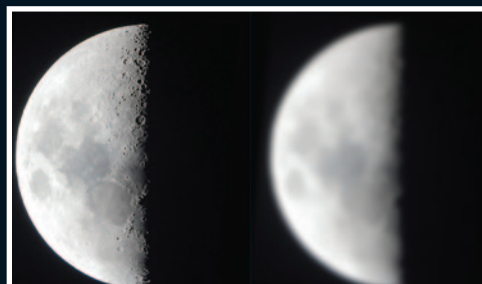
In order to see anything through your telescope, it must be in focus. To do this, point the telescope at the Moon or a bright star. Then, twist the focusing knob until the image of the Moon is sharp or a bright star is as small as you can make it.



Focusing knob



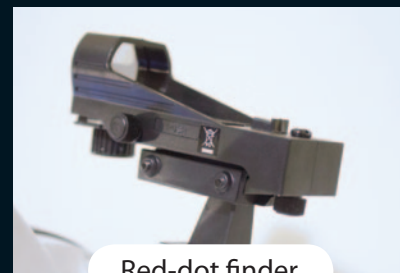
Moon (or polarizing) filter



Moon in focus (left) and out of focus (right)

## Aligning your telescope

For a telescope to work properly, the finderscope (or red-dot finder) must be aligned so that it points at exactly the same place as the telescope. To do this, point the telescope at a bright star. Twist the alignment knobs on the finder scope until the star is centred in both the finderscope and the telescope. If using a red-dot finder, the device must also be turned on.



Red-dot finder

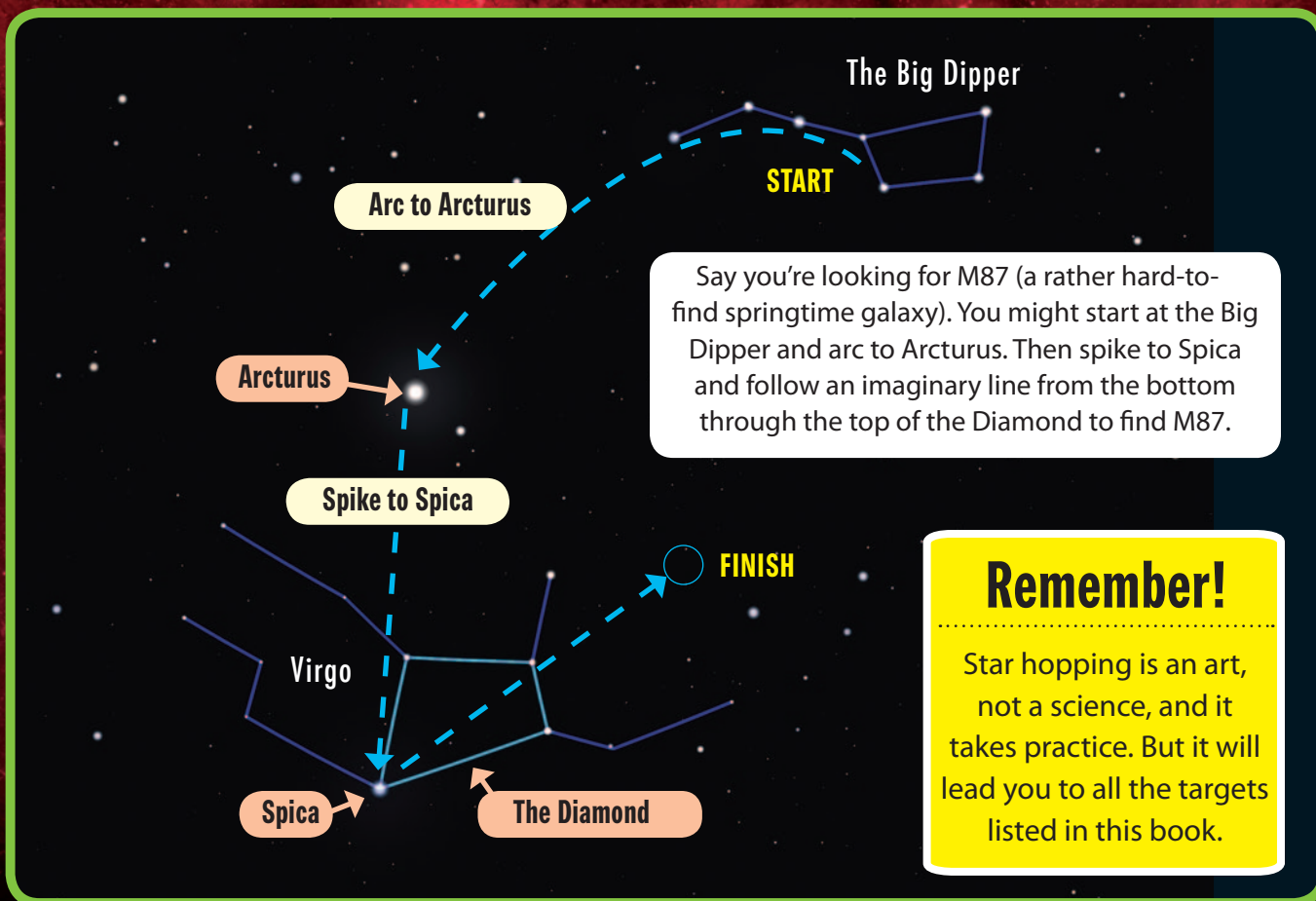
## Adapting your eyes to the dark

Viewing objects like galaxies, nebulae and globular clusters also requires you to prepare your eyes. It takes about 30 minutes to adapt your eyes to see these objects. This means you can't look at car headlights, porch lights or cell phones. It also means no flashlights (unless covered with red cellophane) and no looking at the Moon.



# Star Hopping

To find any object in the night sky, you'll have to plot a route! Imagine you're giving directions to the nearest store. You might say, "Turn right at the traffic signal and left at the stop sign." The same strategy works in the night sky. A seasoned stargazer might say: "Follow the pointer stars to the North Star. Then hop over to Cassiopeia — you'll find the Dragonfly Cluster near the bottom left star in the W." This may sound confusing, but it will come naturally as you learn the constellations and bright stars.



# CHAPTER 1

## Year-Round Objects



# 01 The Moon

The Moon completes a full cycle through its phases about once every 29 days. Each night, the Moon's phase is slightly different.



DIFFICULTY



The Full Moon as viewed through a small telescope or binoculars.



The Moon viewed at the same time each evening.



After the Full Moon, the Moon "wanes" through the following phases: Waning Gibbous, Third Quarter, Waning Crescent and then back to New Moon.

\*As viewed from the Northern Hemisphere



## How far away is the Moon?

Earth

This is a scale image of the distance between the Earth and the Moon.

Moon

The average distance between the Earth and the Moon is 384,000 kilometres.

## Lunar eclipse

Earth's shadow

## Solar eclipse

Moon's shadow

## Stellar Facts

The reason we don't have eclipses every month is because the Moon's orbit is slightly tilted. This means that most months, the shadows miss!

# 02 The Big Dipper & The Surfboard Galaxy

The Big Dipper is the most recognizable shape in the night sky. It is circumpolar, meaning that it stays above the horizon for most people living in the northern hemisphere. The stars in the Big Dipper make great targets to explore with your telescope. In very dark skies, try to find the Surfboard Galaxy (M108) close to the bowl of the Dipper.



The Surfboard Galaxy (M108)

The Big Dipper

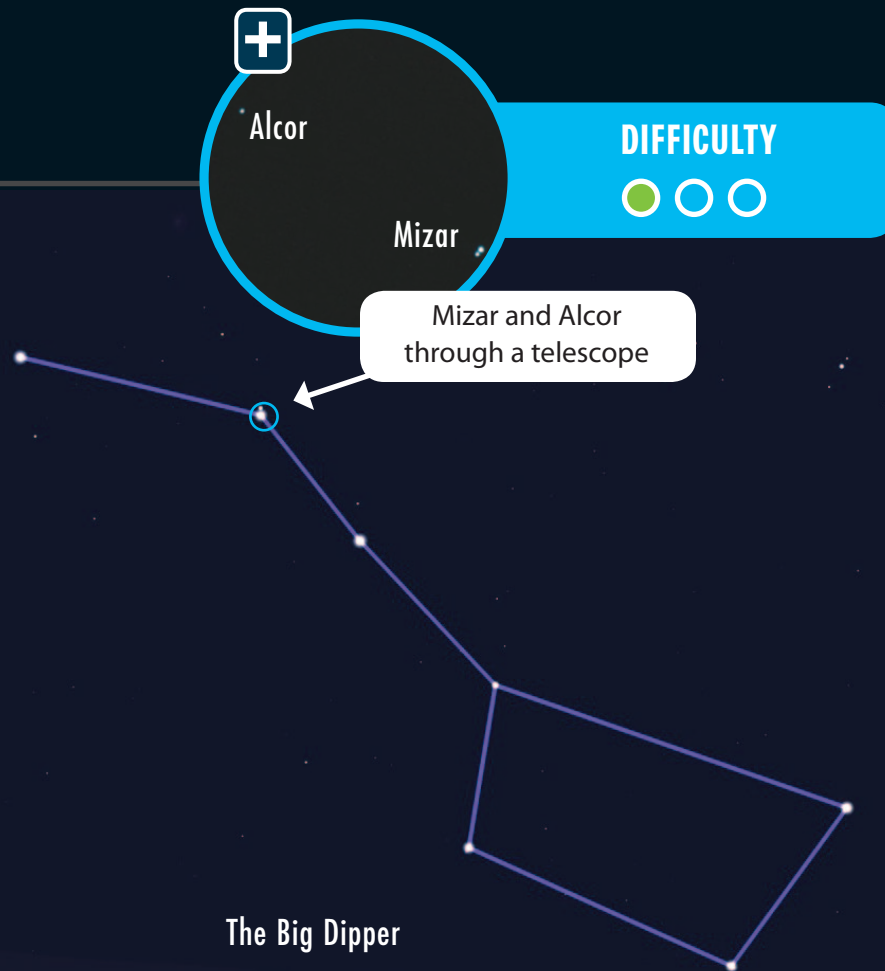
## Stellar Facts



The Big Dipper is not a constellation. It is a pattern of stars within the constellation Ursa Major (Greater Bear). These star patterns are called asterisms.

# 03 Mizar & Alcor

Mizar and Alcor (nicknamed the Horse and Rider) make up the centre of the handle of the Big Dipper. Both Mizar and Alcor are visible without a telescope. What makes them interesting is that through a telescope, you'll notice that Mizar is actually two stars!



## Stellar Facts

Many of the stars you see in the night sky are actually double stars, but most are so close together, and so bright, that they appear as one.

### What are stars?

Stars are giant balls of hot gas, mainly hydrogen and helium. They are held together by gravity and generate heat by a nuclear reaction called fusion. Their colour, which ranges from red to blue, is directly linked to their temperature. The coolest stars are red, while the hottest stars are blue.



# 04 The Whirlpool & Pinwheel Galaxies

These two galaxies, located near the Big Dipper, make great targets for winter, spring and summer (they are a bit low in the sky in the fall). If you're near a town or city, if the Moon is up or if you have not adapted your eyes to the dark, the Pinwheel may be invisible, but in dark skies it's a beautiful sight.



Galaxies often look dim and blurred, mainly due to imperfect sky conditions. Astronomers call these views "beautiful smudges."

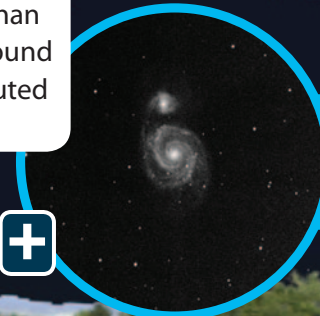


DIFFICULTY



The Pinwheel Galaxy (M101) is visible through a small telescope in extremely dark skies.

The Whirlpool Galaxy (M51) is brighter than M101 and can be found in mildly light-polluted skies.



DIFFICULTY



  
The North Star

The Big Dipper

# 05 The North Star (Polaris)

The entire northern sky appears to move around the North Star — it stays in the same place all year. It is called Polaris because it stays so close to the celestial pole. Many people think it is the brightest star in the sky, but in fact it's number 48. (Sirius, found in Canis Major, wins the prize for the brightest star.)

## Stellar Facts

This star was important for sailors navigating at sea. The angle between this star and the horizon, multiplied by 69, provides the sailor their distance (in miles) from the equator!

The North Star

Find the North Star by following these two "pointer" stars in the Big Dipper.

The Big Dipper

Through a telescope, you may be able to see a companion star, Polaris B.



Polaris A

Polaris B

DIFFICULTY

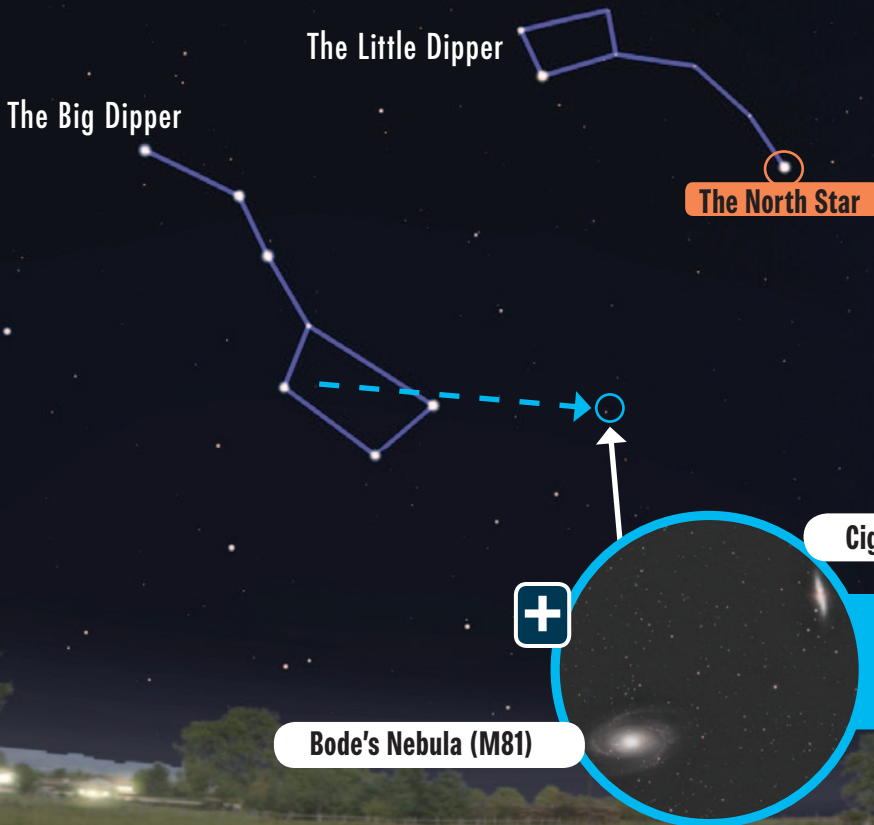




# 06 The Little Dipper & Bode's Nebula

It can be a challenge to identify the Little Dipper because its stars are quite dim. Start by finding the North Star at the end of the handle and work your way over to the cup.

Bode's Nebula, a spiral galaxy, and the Cigar Galaxy (M82) near the Big Dipper are visible through a small telescope almost every clear night. You should be able to see both galaxies at once.



## Stellar Facts



The Little Dipper is a nickname for the constellation Ursa Minor, which means "lesser bear."

## DIFFICULTY





# 07 The Big W & Cluster M103

The Big W (or Cassiopeia) is always found on the opposite side of the North Star from the Big Dipper. Knowing how to find the Big W will lead to several other targets in this book, such as the Andromeda Galaxy and the Dragonfly Cluster. Open star cluster M103 is found within the Big W.



DIFFICULTY



Open star cluster M103 was discovered in 1781.



The Big Dipper

The North Star

The Big W  
(Cassiopeia)

## Stellar Facts



In Greek mythology, Cassiopeia is a vain queen, obsessed with her own beauty.

As Earth spins, the sky appears to rotate around the North Star. For this reason, the Big W may appear on any side of the North Star depending on the time of night.

# 08 The Dragonfly (NGC 457)

Looking more closely at the Big W, you will find plenty of interesting star patterns. The most fun cluster to see through a telescope is the Dragonfly. Recently, this cluster has become known as the E.T. Cluster, named after the alien from the Steven Spielberg movie, *E.T.: The Extra-Terrestrial*.

DIFFICULTY



The two brightest stars are said to represent E.T.'s eyes.

The Dragonfly (also called the E.T. Cluster) through a telescope.

The Big W (Cassiopeia)



# 09 Kemble's Cascade

In the dim constellation Camelopardalis lies a beautiful chain of stars named after Father Lucien Kemble, a Canadian priest. Because Camelopardalis is difficult to identify, you'll need to use the Big W (Cassiopeia) as a guide.

Kemble's Cascade through a telescope or binoculars.



 The North Star

The Big W

Camelopardalis



A star cluster named NGC 1502 can be found at one end of Kemble's Cascade.



DIFFICULTY



DIFFICULTY

