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Stargazing Under Suburban Skies

A Star-Hopper's Guide

The Patrick Moore Practical Astronomy Series

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Dedicated to my father, Harold Zack, who in 1979 helped an enthusiastic teenager purchase a quality 3-inch (76-mm), hand-built British-made Irving achromatic refractor, a classic that survives to this day and was used for some of the observations in this guide.

Malcolm Zack

To Terry Gannon, my father, who inspired me with the delights of the night sky at an early age.

Andrew Gannon

Dedicated to the members of Loughton Astronomical Society past and present who have helped me to make this such a varied and interesting pastime, in particular Steve Eldridge, Steve Richards, Wayne Le Carpentier, Andy Robertson and Charles Munton.

John McRoberts

Foreword

Few observers are fortunate enough to live in a location where the night sky is untainted by the lights from suburbia. But just how much can we spot through the sky glow by star-hopping from object to object?

In 2008, the Loughton Astronomical Society (LAS) was planning its 40th anniversary. As chairman of the society I was looking for projects to celebrate the milestone, and it was subsequently decided to form a catalogue of objects tailored to the needs of observers in cities like our own (North London). Over the next 24 months, members of the LAS helped catalogue the objects they looked at regularly and built up a collection of photographs and drawings. The finalised list of 75 deep sky objects was bound and made available to members of the society and became known locally as the Loughton List.

The bulk of the book (Chapter 4) contains an expanded list of 100 deep sky objects specifically tailored for those living in northerly latitudes in suburban skies. They are ordered in a logical observing sequence, and each is designated with a challenge status: bronze, silver or gold, according to the 'finding' or observing difficulty. Finder charts and LAS images accompany all objects to help the observer. In addition, a diverse list of 30 lunar features has been compiled and laid out in a similar format.

This book aims to reassure suburban dwellers with a little knowledge of the night sky that in addition to lunar and planetary targets, a wealth of interesting deep sky objects lie within the grasp of binoculars, small and moderate telescopes. As the society begins its 50th anniversary celebrations, we hope you will find this a useful and informative guide and that you enjoy reading and using it.

Richard Deighton
Past Chairman of the LAS
February 2018

Acknowledgments

A very big thank you to Patrick Chevalley, lead developer of the star charting software *Cartes du Ciel,* for permission to use the software to produce the charts in Chapter 4 and in the appendix of this book. A summary of the software can be found in Chapter 7, and it is available free to use under the GNU public license. http://www.ap-i.net/skychart/en/start

Thanks also go to the following:

Stephen Tonkin for use and references to his excellent website for binocular users, www.binocularsky.com.

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The British Astronomical Association for use of an image and extract from its journal article on an occultation report involving the authors.

Mark Turner of Moonraker Telescopes for permission to reference his refurbishment work on one of the instruments used in the project.

Most importantly to the members of *Loughton Astronomical Society* who in a variety of ways contributed to this book.

Images and sketches are by Andy Gannon, Paul Julier, Jonathan Daniels, Malcolm Zack, Alan Marriott, Ken Harrison, Douglas Flack, and Martin Peston. Charts are by John McRoberts.

For the text, additional support was provided by John McRoberts, Jonathan Daniels and Steven Richards. Thanks to Richard Deighton, former chairman of the LAS, whose introduction to the society's original list provided the starting point in Chapter 1, and for the Foreword. Proofreading and sense checking was done by Cilla Bell and Brian Morton.

General guidance, technical data, information and author support was given by Allan Bell, Steve Ringwood, and Martin Peston.

Finally to our consulting editors John Watson and Maury Solomon and to the team at Springer for their guidance, support and advice.

About the Authors

Malcolm Zack is an active member of Loughton Astronomical Society, based near London in England. He is mainly a visual observer and leads the society's quarterly sky presentations with fellow members. He still uses his trusty 70-mm British-made 1979 Irving refractor, his first serious telescope from his teenage years. He has also spoken at the society's Autumn Equinox Sky Camp, which takes place annually in northern Norfolk, England, which is one of the largest and most popular star parties in Europe. He is the society's "binocular man," having encouraged many members to undertake binocular astronomy alongside the established telescopic practice. Away from the night sky, Malcolm is an experienced risk and audit professional, having held senior positions across several industries in private, listed and public sector organizations. He also runs his own consulting practice.

Andrew Gannon became hooked on astronomy when he first peered at the Moon through his father's home-made refractor around the age of five in 1959. He became fascinated with the Moon around the time of the Apollo program, observing with his 60-mm (2.5-inch) refractor, and built his own 150-mm reflector as a teenager. He has been a continuous member of the British Astronomical Association since 1972, where he took an active part in the Lunar Section in the mid-1970s under the directorship of the late Patrick Moore. Andrew is one of Loughton Astronomical Society's leading imagers, having won its imaging prize several years in a row. He observes from the relatively light-polluted area of Waltham Abbey, near London's orbital motorway, the M25, using his 132-mm refractor yet still produces results that can compete with those taken in darker skies. A qualified teacher, Andrew taught technology and astronomy. Now retired, he remains a voluntary STEM (Science Technology Engineering and Maths) ambassador and regularly gives illustrated talks on astronomy to youth groups and schools. His other interests are natural history, walking and modeling the railways of the Isle of Wight during the last years of steam.

John McRoberts is an active member of Loughton Astronomical Society and an avid visual observer based in the relatively clear skies of Dunmow in central Essex, England. John's knowledge has contributed to a number of the less well-known objects in the book and in particular some of the attractive and challenging double stars available for amateurs to test their optics and seeing conditions. John is now retired but worked in the telecommunications industry, initially as a production engineer, a computer systems administrator and finally a systems integration test engineer. John's interests are wine, family history and astronomy, primarily visual observing.

Contents

Chapter 1

Seeking Out the Dark

From Messier to the Modern Day

Lists of stars and objects are not a new idea in astronomy. Ancient observers noted the stars in the skies, and as early as the 10th century A.D., the Persian astronomer, Abd al-Rahman al-Sufi, compiled his "book of fixed stars." Today, most astronomers eventually get to know the Messier catalogue or to give it its proper title *Catalogue des Nébuleuses et des Amas d'Etoiles.* The first edition of the Messier catalogue included 45 objects and grew to the 110 that are searched for, sketched, imaged, lost, found and talked about today by experienced observers and beginners alike the world over.

Others, such as the *New General Catalogue* (NGC), the *Index Catalogue* (IC), and specific lists including the Herschel 400 and the Caldwell objects generated by Sir Patrick Moore, provide ample resources and targets to challenge and occupy the observing nights for astronomers everywhere. Since 1758, when Messier first published his catalogue, improvements in optical, radio and infrared technology have allowed us to see things that he could not have imagined.

Amateur telescope technology has moved on apace, too. The price point of a seriously good telescope has dropped to affordable levels for almost everyone. Messier's 3.5-inch refractor would be more than matched by the marvels available to amateurs today.

Sadly, however, the quality of skies in urban areas has declined markedly. What you can realistically find and really see in and around London, Manchester, New York, Chicago, Los Angeles and other major towns and cities in the early 21st century does not compare to the descriptions written by observers fortunate enough to have regular and safe access to wonderful inky black skies.

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It appears to be a battle that ground-based astronomers are not winning. As our society develops, the appetite to light up the night appears insatiable. Centers of cities and even small towns are awash not just with street lighting but giant outdoor video screens and billboards.

Concerns over security encourage the use of lighting to deter crime. Although the arguments for such concerns are valid, the power and scope of even domestic security lighting turns night into day at the flick of a switch or by the detection of movement. Drive along a smart street in suburbia, and cars parked in driveways are bathed in low lighting to highlight the parking area or even the vehicles themselves. Light gets reflected, and much of it bounces back up into the skies. If the sky has haze or slight mist, the tiny particles can spread the light even more to build a general glow. Observers on the edge of cities and towns will be familiar with local domes of light that creep up part of the sky. Often orange in color due to the use of sodium lighting, the affected sky gradually dissolves into a peach shroud, through which only the brightest and most stubborn stellar objects can shine.

At open air gatherings or events, lasers and light shows tear across the ether to the "oohs and ahs" of the crowds below, most of whom are oblivious to the far more impressive light show above the atmosphere, that provided by the heavens of our galaxy and the universe beyond. Much of this artificial light is wasted and has an economic cost as well as an impact upon wildlife. These are slowly becoming more understood as are the impacts lighting has upon human health. Too much light, particularly at the blue end of the spectrum, can disrupt sleeping patterns and the circadian rhythms that our bodies have evolved with.

The overall effect is that the night sky is being hidden from us and, more importantly, hidden from our children. We are part of the universe, yet comparatively few of us take time to look up and take in the majesty of the night sky. Sometimes, for many non-astronomers, it can take a visit to a remote part of the country or abroad to jolt them into understanding what we are missing. How many people have never seen the Milky Way? No doubt this is many millions and shows no sign of decreasing.

So, if this all sounds somewhat depressing, what can be done about it and why bother observing anyway?

Valiant efforts to promote awareness of the problems of light pollution are led by organizations such as the Commission for Dark Skies in the United Kingdom, which leads initiatives and provides guidance and lectures to highlight the impact of city and suburban lighting and to encourage more effective means of lighting up our world. One would think that the main argument would be so that we could all see the stars more easily. Of course, that is a primary aim, but the organization outlines the impact on the environment generally and how sensible lighting approaches can be of benefit to society.

The International Dark-Sky Association, based in Tucson, Arizona, shares similar aims. In parts of the United Kingdom, for example, some local authorities have recently started switching off street lighting from midnight to around 5 a.m. This has met with mixed reactions for many of the reasons above, such as security, and in some cases the number of hours without street lights has been reduced. Nonetheless, a drive through the country will take you through "dark" villages where the principle of no street lighting is part of the local authority requirements. Loughton Astronomical Society used to be based in Loughton, Essex, when it was founded in 1968. It has since moved about 5 miles from Loughton to Theydon Bois, where the number of street lights and other forms of lighting for public buildings and social clubs is limited by planning laws.

People from all walks of life who take up astronomy as a hobby or as a vocation live in towns and cities. Despite all the problems described above, many are active observers and participants in local societies. We may complain and moan about the poor skies where we live, but when the clouds part and darkness descends, lenses and mirrors are turned upward, and countless curious eyes peer into eyepieces to seek the starlight that has traveled for tens, hundreds, thousands and even millions of years.

That is the magic. That is the fascination that draws astronomers outside, away from the comforts and warmth of our homes and buildings, out into the night, seeking out the dark.

A Companion for Observers Based in Suburban Skies

So how does this book help? It can be a great companion to relative newcomers and more experienced observers who do nightly battle with orange-gray skies, eye-piercing street lamps, stubbornly placed trees and inconveniently sited houses.

This book aims to help amateur astronomers find and enjoy popular and interesting objects visible in suburban skies. It is not intended to be a book for absolute beginners, so while some guidance is provided on the star charts and constellations, some basic knowledge of the sky is assumed, and readers are referred to well-known publications that can help them learn the constellations and major star names. These are listed in the Bibliography at the end of this book. Help is also readily available online these days, and with world-conquering smart phones, star atlases and apps provide portable reference guides.

Our intended readers are those who own relatively modest equipment ranging from binoculars to refractors of 70 mm to 150 mm or reflectors of up to the 200 mm class. Many of the observations and images in this guide were undertaken with such equipment, which is described in Chapter 3 of this book. Those with larger instruments or those lucky enough to have access to darker skies will still find many of the target objects of interest and suitable to share with others.

Although focused on northern hemisphere observers, visitors from more southerly climes should find it a helpful introductory companion. The hope is that users of the guide will develop their knowledge such that when they are fortunate enough to have an opportunity to observe in darker and clearer skies, they can enjoy favorite objects even more and be able to share them with fellow observers.

This book is based on an original list of objects that experienced members of Loughton Astronomical Society drafted for its membership around 2011. The list had to include objects that could be found using star-hopping methods rather than relying solely on a GOTO telescope.

The project originally started with 20 or so objects that less experienced members could locate in a typical year to help them learn their way around the sky and to be able to point out some famous objects to their family and friends. The criteria were that objects had to be seen reasonably well from our light-polluted, tree and house-dominated skylines without the need to resort to sophisticated instruments, accurate polar alignment and GOTO telescopes, although these could still be useful.

This meant that the objects would generally be from middle to higher altitudes in the sky and typically binocular objects or smaller telescopic ones. This became known as the ‘Loughton list.’ It became clear that the initial draft list of 20 objects was insufficient, so it was

later expanded to over 60 to allow a choice of plenty of objects to be seen throughout the year. In fact, the first members' publication of the 'Loughton list' included 75 objects, many very well known and found in most popular atlases and observing aids.

This book is a more comprehensive version of the original list and includes over 100 deep sky objects. Several dozen more objects are referred to in the text. Some well-known objects that are observable from the mid-northern United States and southern European latitudes are not included, and lower positioned objects that are often hidden from view or lower down in the murk have not made the list, even though some observers would recommend their inclusion. Nonetheless, there are some that are a bit easier to see if you have a good southern horizon or are observing from those locations.

There is a range of object types, including clusters, galaxies, variables and double/triple stars, plus some fun asterisms and unusual items such as deep red carbon stars that shine like a malevolent eye. If the book has omitted any of your own particular favorites or included items that may surprise you, please accept the authors' apologies! Many an hour over tea and biscuits (cookies) was spent debating the merits of each one. Was it truly a suburban object or one that was really for the darker skies? At the end of the day (and night), the observing team think they more or less got it right.

We extended the concept of the list to suburban observing in general. It may surprise some readers, but there is a wide range of astronomical phenomena that can be observed from those locations. Astronomy is a vast subject, and observers develop their own specific interests. This may be derived from where they live (inner city dwellers may focus more on the Moon or planets and country-based observers on deep sky objects such as galaxies), or on particular interests such as photography. Some observers enter the hobby through other interests such as bird watching, having turned their spotting 'scopes upwards one night and becoming hooked.

The simple pleasures of astronomy are free (not counting equipment costs, of course). You don't need an annual membership fee or a ticket to look up on a clear night. Learning the names of the major stars and constellations is rewarding in itself, and newcomers to the hobby are always encouraged to take time first to do this before jumping feet first into buying telescopes, even though some of these have the ability to find things almost by themselves these days!

In fact, having a good sense of the way around the night sky and the major stellar signposts is a key skill for the suburban astronomer. Constellations have a habit of hiding behind trees or lurking behind your neighbor's rooftop. Knowing where a particular object you wish to observe is likely to be positioned at the time when you venture outside helps plan your session and avoid the frustration of setting up your equipment only to find you can't see it!

The charts in this book are designed to help find objects in a local area, but some knowledge of the wider sky is assumed. Help is at hand in some of the sources listed at the back of the book, and there are many advantages in joining a local astronomical society. There are countless societies all over the world, and a simple search on the Internet should help identify groups nearby. They vary in size and activity, and most these days have their own website for contact information and upcoming programs. Most will give talks on what is currently visible in the sky and hold observing sessions where experienced observers will be on hand to guide beginners.

As you develop your interest, no doubt some investment in equipment will be necessary, but our advice is to take your time to research before buying and whenever possible look through

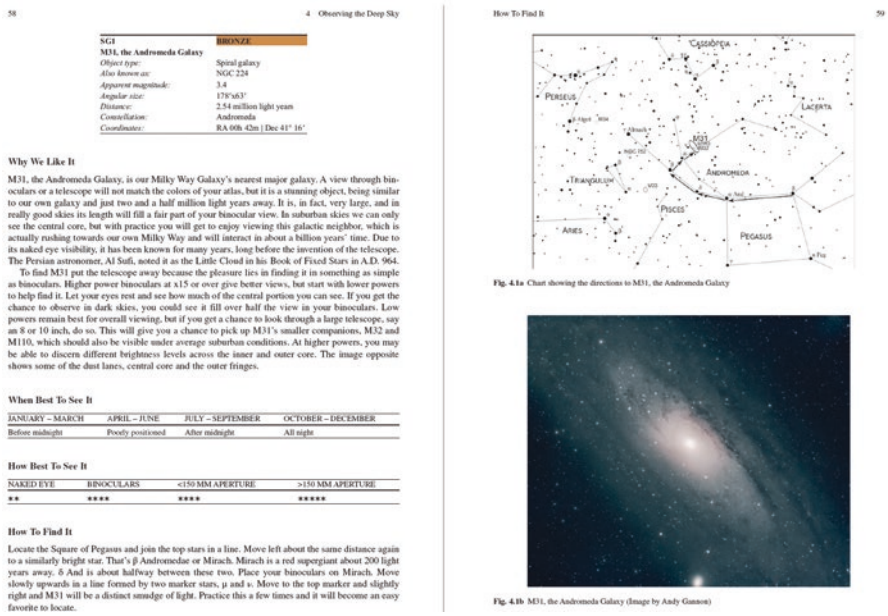
equipment owned by others. It may seem to be an expensive hobby, but it does not have to be. Even those on a tight budget should find equipment that will give them a lifetime of quality observing. Many of the objects in the guide are well within the grasp of a pair of modestly priced, suitably mounted binoculars.

Bronze, Silver and Gold Designations

The Bronze, Silver and Gold ranking of objects in this book leads observers through the team's favorite deep sky objects. Many of these are well-known, some perhaps less so, and using star-hopping techniques, the book teaches the way around the sky. Each object has a detailed description from an observer's point of view and a 'Why We Like it' section. As a result, readers will gain a sense of the 'view from Earth' from their backyards and gardens, pavements and sidewalks and a host of popular objects to share with friends and family.

Bronze objects are the easiest and for the least experienced. Many of these are visible to the naked eye or at least visible in fair skies with binoculars. Silver-ranked objects present a bit more of a challenge and may be seen more easily in small telescopes with a little more power than typical binoculars. Gold objects include some of the lesser-known but interesting targets that are still visible from towns and cities. These are admittedly the most challenging, but they are well within the reach of experienced observers with a good chart and patience.

Each object in the star-hopper's guide has a designation of SG(n) and its own page explaining its official designation, some basic technical data, why we like it and how to find it using star-hopping techniques. On its adjacent page the relevant finder chart and image are shown. Fig. 1.1 below illustrates the basic layout.



58 4 Observing the Deep Sky

SG1	BRONZE
M31, the Andromeda Galaxy	
Object type:	Spiral galaxy
Also known as:	NGC 224
Apparent magnitude:	3.4
Angular size:	178'x63'
Distance:	2.54 million light years
Constellation:	Andromeda
Coordinates:	RA 00h 42m | Dec 41° 16'

Why We Like It

M31, the Andromeda Galaxy, is our Milky Way Galaxy's nearest major galaxy. A view through binoculars or a telescope will not match the colors of your atlas, but it is a stunning object, being similar to our own galaxy and just two and a half million light years away. It is, in fact, very large, and in really good skies its length will fill a fair part of your binocular view. In suburban skies we can only see the central core, but with practice you will get to enjoy viewing this galactic neighbor, which is actually rushing towards our own Milky Way and will interact in about a billion years' time. Due to its naked eye visibility, it has been known for many years, long before the invention of the telescope. The Persian astronomer, Al Sufi, noted it as the Little Cloud in his Book of Fixed Stars in A.D. 964.

To find M31 put the telescope away because the pleasure lies in finding it in something as simple as binoculars. Higher power binoculars at x15 or over give better views, but start with lower powers to help find it. Let your eyes rest and see how much of the central portion you can see. If you get the chance to observe in dark skies, you could *see* it fill over half the view in your binoculars. Low powers remain best for overall viewing, but if you get a chance to look through a large telescope, say an 8 or 10 inch, do so. This will give you a chance to pick up M31's smaller companions, M32 and M110, which should also be visible under average suburban conditions. At higher powers, you may be able to discern different brightness levels across the inner and outer core. The image opposite shows some of the dust lanes, central core and the outer fringes.

When Best To See It

JANUARY – MARCH	APRIL – JUNE	JULY – SEPTEMBER	OCTOBER – DECEMBER
Before midnight	Poorly positioned	After midnight	All night

How Best To See It

NAKED EYE	BINOCULARS	<150 MM APERTURE	>150 MM APERTURE
**	****	****	*****

How To Find It

Locate the Square of Pegasus and join the top stars in a line. Move left about the same distance again to a similarly bright star. That's β Andromedae or Mirach. Mirach is a red supergiant about 200 light years away. δ And is about halfway between these two. Place your binoculars on Mirach. Move slowly upwards in a line formed by two marker stars, μ and ν. Move to the top marker and slightly right and M31 will be a distinct smudge of light. Practice this a few times and it will become an easy favorite to locate.

How To Find It 59

Fig. 4.1a Chart showing the directions to M31, the Andromeda Galaxy

Fig. 4.1b M31, the Andromeda Galaxy (Image by Andy Gunson)

Fig. 1.1 The layout of text, charts and images in Chapters 4 and 5

The right ascension[1] (RA) and declination (Dec) of each object are provided so readers who are familiar with electronic GOTO or Push To instruments can search for them that way if they wish. Appendix B in this book provides detailed positions, although most GOTO systems will have the named objects in their databases.

All objects in the book are included in the eight general sky reference charts provided in Appendix D of this book. Collectively, these show all relevant regions of the sky and can be useful for planning an observing session.

Tools, Techniques and Other Astronomical Phenomena

Chapter 2 explains methods and techniques for observing in suburban skies, including star-hopping. It considers the wide range of locations in which town dwellers find themselves and how to make the best of the sky by minimizing the effects of lights and buildings and includes an introduction to useful equipment. It also covers areas such as understanding the size and measurement of the sky and technical terms such as apparent field of view. These are key in learning and moving around the night sky.

Chapter 3 covers the telescopes and equipment used by the observing team to make the images and drawings and to test the star-hopping directions. There is a considerable range of instruments, including handheld binoculars, small modern refractors, larger apochromats, Newtonian and Cassegrain reflectors and even a classic telescope with a lens dating back to the 1940s. The chapter continues with a review of types of mounts, eyepieces and related equipment including using filters for visual and photographic use. A section on sketching aims to encourage observers to record observations using more traditional methods. The message from this chapter is that there is no one best type of equipment for observing, however light or dark the sky may be. Whatever you have at your disposal can provide years of enjoyment and learning.

Chapter 4 is the largest chapter in the book and contains the main list of deep sky objects. It starts with those best found in the early autumn of the northern hemisphere and progresses eastwards around the sky. There are 100 Star-Hopper's Guide (SG) objects. Others that may be nearby or on the way to the target are highlighted in the text or on the charts. All in all, the book mentions nearly 200 objects. A list of the 100 is provided in Appendices B and C of this book. These and other features are listed in the index.

Chapter 5 contains 30 of our favorite features on the Moon. This is the easiest and most detailed object visible from suburban areas and is an obvious candidate to include! Indeed, for some observers located well into town and city centers, the Moon is the best target, as it is largely unaffected by light pollution, although tall trees and buildings still manage to get in the way! Other features in and around the 30 targets are highlighted, so the reader will build up an initial inventory of over 50 interesting objects to track along the lunar surface. It uses the same grading, charting and imaging styles as the deep sky list, and it is intended to provide a launch pad for readers to observe the Moon in more detail.

[1] Right ascension and declination are the celestial equivalent of longitude and latitude. RA is measured in hours from a position known as the vernal equinox, a kind of 'Greenwich Meridian' on a star chart. There are 24 hours of RA around the sky. Declination is measured in degrees from the celestial equator.

Chapter 6 on planetary positions and good observing times over the next 30 years up to 2050 completes the main observational sections. There are many excellent publications and sources of information on the Internet about the planets, and this chapter highlights where to find them and some basic observational data.

Chapter 7 covers reviews on some of the astronomy apps that are widely available and other astronomy software. There are some outstanding books and guides on astroimaging. It is not our intention to cover this rewarding part of the hobby in this book. However, all with the exception of two of the images were taken by members of the society from their homes and locations in suburbia, on the edge of London or the nearby counties of Essex and Hertfordshire. Imaging is certainly possible from suburban skies with patience, so a section on software and techniques used by Andy Gannon is included. Appendix A in this book outlines the technical methods used for the images in the book and summarizes equipment and methods used by other imaging contributors.

Chapter 8 brings together other objects and events that can be observed from almost anywhere in towns and cities such as lunar eclipses, meteor showers, occultations, planetary conjunctions, bright asteroids and solar observing. So, although the main focus of the book is the deep sky star-hopping objects in Chapter 4, this chapter, along with Chapters 5 and 6, bring together other areas of observational and photographic astronomy that are possible from suburban areas.

An astronomy guide often relies on the expertise of others, and so during our research, various well-known books and online sources were utilized. Readers will find these publications and sources enjoyable additional reading, leading on to more objects to seek and find. A full list is provided in the Acknowledgments and Bibliography sections.

A Society Project

This book is a Loughton Astronomical Society project involving over a dozen members. It has certainly improved everyone's knowledge of the night sky, while at the same time being a lot of fun. Thanks are extended to everyone who contributed to the guide in a variety of ways. Without them, we would still be in the dark.

Chapter 2

Observing in Suburban Skies

You *can* observe from there! Don't be put off by comments or grumbles from country dwellers or those with vehicles and safe access to dark skies. It *is* harder to see galaxies, and clusters may not be quite as jeweled as described, but there are methods and techniques to enhance your observing session from wherever you are located.

In this chapter, we cover locational observing followed by specific hints and tips for making the most of the sky.

Making the Most of Your Location

Observing from a Flat or Apartment

Tower block astronomy has two main problems: lighting and restricted views. It helps if you have a balcony or access to a roof area.

Try shielding or turning off lights on the balcony or porch. Keep any room lights, TV screens and computer monitors off because these contribute to stray light. Use blinds or curtains and talk to your neighbors. Hopefully they will understand the impact of light and will turn off or turn away any security lighting or internal lights. If you have a balcony light, consider changing the bulb to a red one to help keep dark adaptation as effective as possible.

Although a balcony may have a restricted view, make the most of the sky area that you can see, especially if you can get above rooftops and the tree line. The Moon will be a good choice for low horizon views.

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Fig. 2.1 Suburban astronomers can be inventive as well as brave! Loughton Astronomical Society member Doug Flack perches his camera on a homemade extension rod to capture wide field views from his flat in London. (Image courtesy of Doug Flack. Used with permission.)

Carrying a telescope down flights of stairs or using an elevator to the apartment's gardens or driveway may be the only option for some. In this case, pick a smaller instrument such as a refractor to minimize the number of trips you need, and try to avoid leaving equipment unattended if you can.

If all you can do is observe from an open window, work out what part of the sky you can see and plan your observations and targets accordingly (Fig. 2.1). It may be best to focus your observing on objects such as the Moon and brighter clusters as they move into view. Chapter 5 highlights 30 lunar objects to get you going. There are numerous books on lunar observing that can be rewarding for city dwellers, and images of the Moon across the city landscape can be attractive.

Wide field views of the night sky are still possible, and learning your way around the stars and constellations can be easier when there is less to see (Fig. 2.2). Dark skies littered with stars can sometimes be confusing, even to experienced and knowledgeable observers.

Garden Astronomy

Stargazing from your garden or backyard offers many advantages to the suburban astronomer. Compared to trekking out to a park or open field, it is secure and provides room to set up equipment, something to sit on, tables (to put this book on!) and just a few steps from the warmth of the kitchen and that all-important cup of tea or coffee!

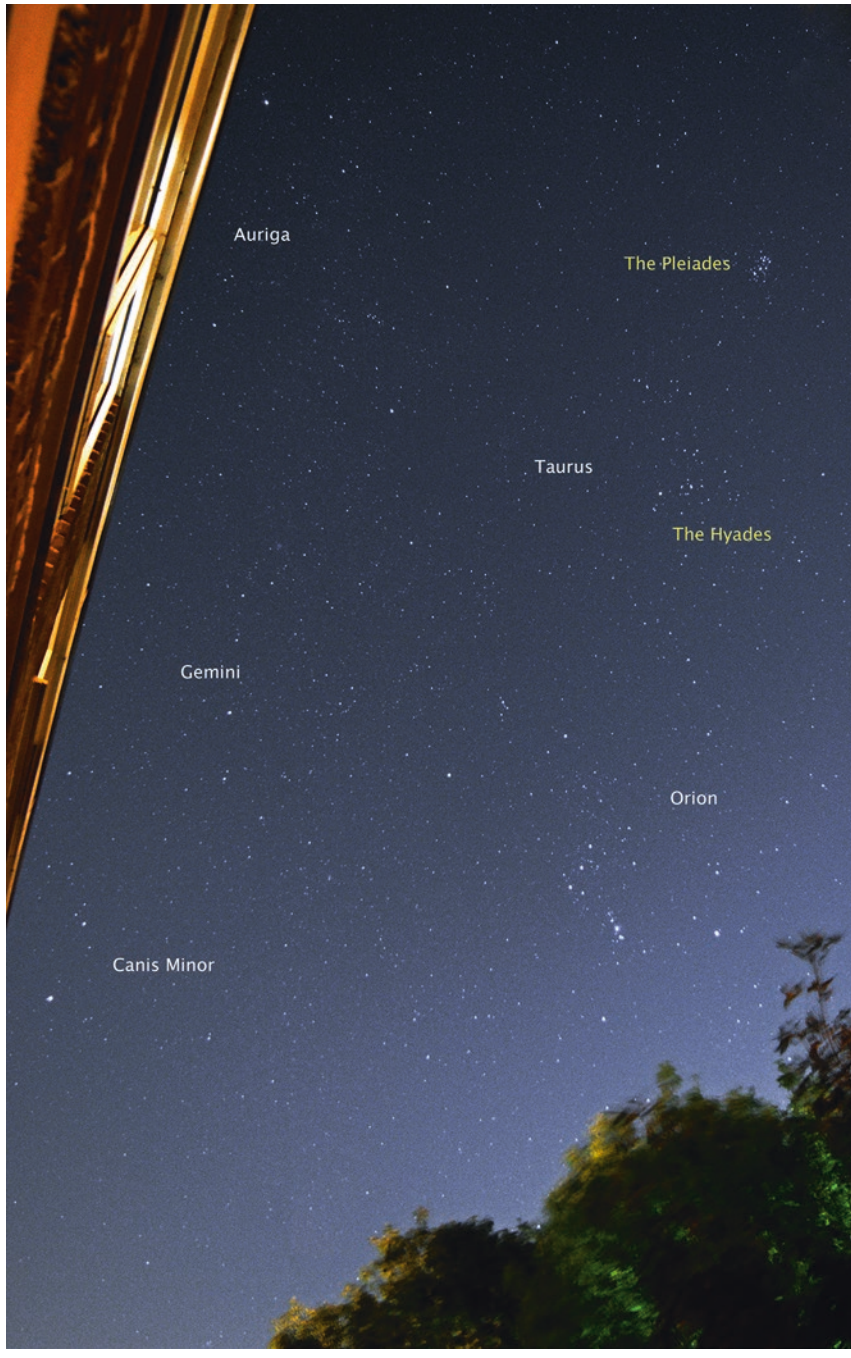

Fig. 2.2 A view of the winter constellations squeezed between an apartment block and nearby trees. (Image courtesy of Doug Flack. Used with permission.)

During the day, look around the sky and horizons from your garden and determine which areas may present wider views. Are there trees just due south? Can you position yourself so that you can still see the star Polaris if you chose to align your telescope and use GOTO methods? Is there a gap between the houses where a low positioned Moon or planet will be visible? Orientate yourself to the cardinal points of north, south, east and west and determine where your major town or conurbation is. That is where the familiar 'orange bowl' of light may appear at night.

Look across at neighbors for any lights from windows or security lights that may shine across your line of sight from certain locations in your garden. Where are the street lamps positioned? Are any placed behind trees? These may be partly shielded during spring and summer, but after the autumn (fall) their impact will be greater.

Consider if there are any natural light shields. Positioning yourself alongside a fence or line of trees may restrict some of the view, but these may be tall enough to block out some lights and protect from the wind. Then repeat the exercise at night, even if it is cloudy. This will help identify preferred spots for different objects. On one occultation of the planet Saturn by the Moon, for example, author Malcolm Zack was able to observe the whole event from one extreme edge of the garden over the western horizon, whereas from his usual favored spot the Moon would have sunk below a line of trees well before the end of the event.

Check where the glow from towns is greatest and where the sky appears a bit darker. You may not be able to see everything, but most objects move in and out of favored areas, so you will get an idea of what is possible and when.

Dew is often a problem that requires dew bands and power to heat these to keep dew from forming on the lenses or mirrors. Some observers use portable power packs such as the Skywatcher or Celestron brands, which will usually provide several hours' power on a single charge. (See Chapter 3 for a discussion on how to use dew bands.) Others may use household power from an external power socket or by running a lead through a window or door from inside. Only use equipment that is designed to be used outdoors and has the appropriate safety protection. It is very important to note where your leads lie and provide some protective cover to avoid tripping over them in the dark.

Observing from your front garden or driveway is also an option and may be the only way you can see objects that are otherwise hidden from your back garden by your house! Just be aware that this may not be as secure so don't leave your instruments unattended if you are on a busy street. However, you may well attract interested passers-by, and this can turn into an enjoyable and social evening!

Backyard Observatories

Some readers will be fortunate enough to have or have access to a home-built observatory. Such observatories range from adapted garden sheds to professionally constructed domes (Figs. 2.3, 2.4, 2.5 and 2.6). Sometimes a shed is a more favorable option, as its contents will be less obvious to casual passers-by. Observatories with roll-on/roll-off roofs provide all the flexibility of the garden lawn with the addition of storage, protection from wind, some protection from the cold of night and usually require just a short period of setting up before observing begins.

The location of your observatory will be a crucial decision. As with lawn-based positioning, determine the most advantageous part of the sky and be prepared to make some compromises over horizons, rooftops and street lamps. The walls of your observatory may create an artificial horizon, too.

Fig. 2.3 Positioning your observatory – a battle of lights, horizons and garden plants! This observatory is sited at the top of a sloping garden and accessed by a series of steps. The side panel drops down to provide a good southern horizon, and the roof partly blocks a very annoying and inconsiderate street lamp! (Image by Andy Gannon)

Fig. 2.4 Even a small shed can be a practical and inexpensive solution to protect against the elements. (Image courtesy of Dave Gill. Used with permission.)

Fig 2.5 A roll-off roof 3 m by 2.5 m (10 ft by 8 ft) observatory is sited in the north-west corner of the owner's garden. This affords better views to the darker northeast section of the sky and is only partly impacted by the wire fence. The tree to the west has since been removed, revealing more of the light dome from London positioned south and west. (Image by Malcolm Zack)

Observing in Town and With Others

Observing with others can be the most enjoyable part of astronomy and is possible even in the world's largest cities. The Baker Street Irregular Astronomers meet monthly in the center of London's famous Regent's Park, just north of the absolute center of the city. Dozens of visitors of all abilities flock to 'The Hub' with a variety of instruments (Fig. 2.7). Their Facebook page updates members on observing meetings dependent on weather conditions, and is used as a means of sharing images, observations, alerts and advising new joiners. Members observe the Moon, planets and many of the objects listed in this guide.

Lights and buildings present the same problems, but it is possible to move away from the brightest of these to comparative darkness. We would always recommend, however, that if you choose parks or open areas in towns and suburbs, you do this accompanied by a friend for your own safety. Do be careful if you are on your own with attractive and expensive-looking equipment!

Holidays and Hotels

Taking a vacation in warmer climes can also present an opportunity for town dwellers to pursue objects that are lower in their home skies. However, popular tourist destinations can be among

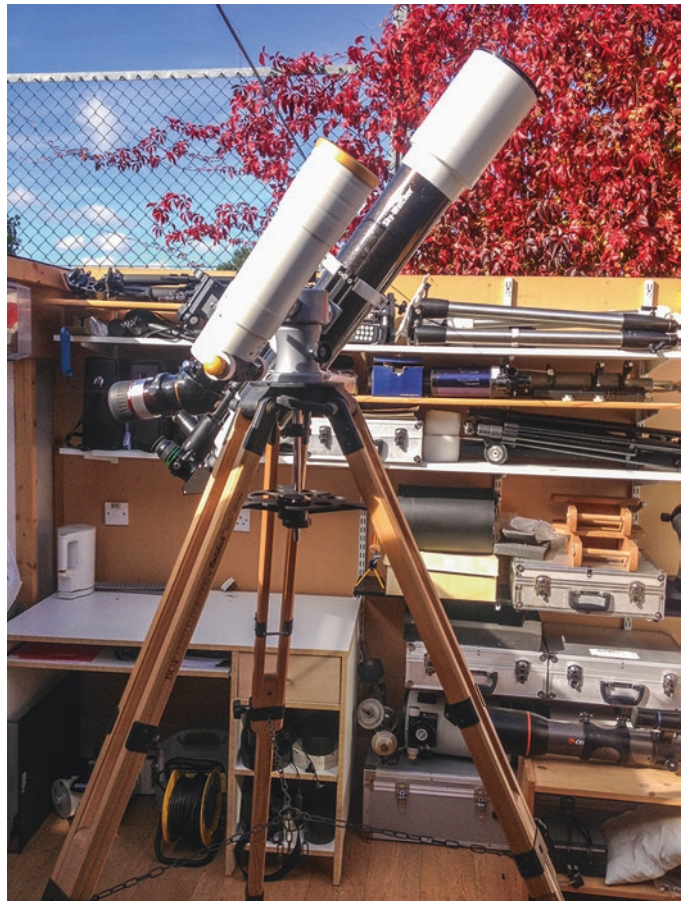

Fig. 2.6 The interior of the observatory with the open roof, showing nearby fencing. (Image by Malcolm Zack)

the worst offenders for light pollution. Hotels will have many lights on for guests as they party into the early hours. For the traveling astronomer with a family hoping to get a few new views for an hour or so, this can be a bit disheartening, but our tips below will help mix sun, sea and sand with the stars:

- Travel light. Take a small short focal length refractor or a pair of binoculars. Many of these are light enough to be fitted to a small portable tripod, and binoculars can be fitted with an L bracket. They can be small enough to be transported as cabin luggage.
- Tour the hotel and its gardens. You may be able to find an interesting perch with a good horizon that is shielded from the lights.
- Check out the beach but keep safe if you go there. It may be darker there but you can be at risk if it is deserted.
- A light tripod set-up is easy to move around.
- If your room has a balcony, consider some of the tips from our apartment section. Just make sure your eyepieces don't get knocked off and end up in the swimming pool below!
- If you have rented a villa or a cottage, you may have lower light levels and may be able to block out or turn off nearby lighting.

Fig. 2.7 The 'Hub' in London's Regent's Park at dusk. If you can observe from the center of London, you can observe from practically anywhere! (Image courtesy of Richard Deighton. Used with permission.)

- If you have the requisite solar filters, daytime astronomy can also be fun while on holiday, but limit access to the eyepiece if there are lots of non-astronomers around. The Sun is clearly visible for suburban dwellers. Due to the specialist nature of solar observing and the many excellent books on the subject, we have not included our nearest star as an object for detailed examination in this book, but we do outline the basics of solar observing in Chapter 8.

Making the Most of the Sky

Finding your way around the sky in heavily light-polluted towns and cities can be a challenge, and finding deep sky objects in those skies even more so. In such skies, one is often limited to seeing the brightest stars unaided (often just those down to third and fourth magnitude), which means that all but the brightest constellations such as Orion and Cygnus can only be partly seen and as a result appear indistinct.

Being in such light-polluted skies, though, should not be seen as an impediment to enjoyable astronomy, and many worthwhile objects can still be well seen. When you are familiar with the night sky then star-hopping is often the quickest way to find many objects and will save you a lot of time when you want to have a quick observing session.

Starter Objects

The objects you should start with and learn first are the names of the brightest stars and where to find them, typically those down to second magnitude. A good place to start is with Polaris, so you can always find north, and then the bright stars of the Summer Triangle (Altair, Deneb and Vega) and the Winter Triangle (Betelgeuse, Procyon and Sirius). It is worth having a knowledge of the whereabouts of the bright naked-eye planets. These are often easy to find, as at their brightest, they are the first to appear in the twilight. The planets do move through the sky, however, so it is worth checking their current location using planetarium software or apps. (See Chapter 7 for a discussion and review of popular software and apps.)

Next move on to some of the naked-eye brighter double stars covered in this book, such as Albireo, and Mizar. The best objects to follow on from these are probably some of the brightest open clusters such as M45 (the Pleiades), which can be seen with the naked eye even in urban skies. (M45 is SG15 in Chapter 4 of this book.)

Which Equipment Helps?

Chapter 3 details some of the equipment used to compile this book and the different types of telescopes and mountings available. When few stars or constellations are visible, some of the most useful tools to help you find your way around are those that provide a wide field of view. Binoculars fit the bill best here, and 8x42 and 10x50 instruments will help you to pick up otherwise hidden stars.

A good starter telescope for star-hopping is one with a relatively short focal length of 500 to 1,000 mm, so short tube refractors and Newtonian telescopes are worth considering. Ideally, such a telescope will provide a 2 to 3 degree field of view, with a low power eyepiece giving 20 to 30x magnification. It will probably be easier to line up targets and move your telescope quickly with an altazimuth mount rather than an equatorial mount (Fig. 2.8).

Some observers prefer to use a red dot finder to locate a target because it helps to see as wide a field as possible. A useful combination would be to pair a red dot finder with a relatively inexpensive 8x50 right-angled finder that provides a wide field combined with the ability to see fainter objects in the surrounding star field.

The next key area of equipment is a high-quality star atlas. Along with this guide, there are numerous books to choose from plus many software programs and star charts.

Star-Hopping: Triangles, Squares and Diamonds

An effective way to begin to find a deep sky object that cannot be seen with the naked eye is to locate a star or several stars nearby you can see. Then visualize lines from those naked-eye stars to the object you are looking for. Using the charts in this guide will help. Alternatively, imagine two visible stars sitting at the two points of a triangle, where the object you are seeking sits at the third point. Using a red dot finder can help to identify these

Fig. 2.8 Jonathan Daniels, LAS member who regularly demonstrates star-hopping, with his altazimuth mount supporting a wide field refractor for finding and locating and a larger, long focal length Schmidt Cassegrain telescope for higher power and more detailed views. Note the red dot finders mounted on each. (Image by Andy Gannon)

points. (See Chapter 3 for more on red dot finders.) Next either use a finder scope, which will show many brighter deep sky objects faintly, or begin using the telescope with the lowest power eyepiece available. If you can't see the object, sweeping in a spiral moving outward should eventually bring it into view.

In addition to the techniques outlined above, stars can form other memorable shapes such as squares, trapeziums or diamonds. Use the shapes identified in the charts in this book to help you locate that same shape in the instrument's finder. This should help you find the target object in the eyepiece of the telescope. Some stars form useful markers on the way, others just snake their way like a roller coaster (switchback) towards the object. Our charts and guides suggest some of these, and you may well develop your own directions and marker stars as you get proficient.

Understanding Field of View and Degrees

In this book, the directions and star hops will frequently define distance in terms of degrees and field of view (FOV). From one side of the sky to the other is 180 degrees. From the horizon to the zenith directly above you is 90 degrees. Moving from one star or object to another can be measured in the same way. If you hold your fist out at arm's length, that fist usually covers about 10 degrees. An outstretched hand covers around 20 degrees from thumb to fingertips.

Translated onto the sky, if you look at the two pointer stars in the Plough (or Big Dipper) that point to Polaris, these two are approximately 5 degrees apart. In comparison, the full Moon covers just half a degree!

When looking through binoculars, your FOV will be narrower because you have magnified or 'zoomed in' on your view. Low power binoculars such as 6x30, 7x50 or 8x42 typically have a 6-7 degree FOV. This reduces as the power goes up. The 10x50 normally shows 5 degrees, whereas this reduces to 4 degrees at x15 or no more than 3 degrees in say a 20x80 pair.

When looking through a telescope the FOV depends on the magnification and type of eyepiece being used. Some eyepieces have their apparent field of view (AFOV) marked on their side. AFOV can range from the relatively narrow orthoscopic and Plossl eyepiece designs (40 to 50 degrees AFOV) up through wide field designs that may go from 68 degrees to as high as 82 or even 110 degrees. The actual field of view you will see in your eyepiece will depend on the magnification your chosen eyepiece provides in your telescope, which in turn depends on the telescope's focal length.

For example, let's assume you have a medium field eyepiece with a 60 degree AFOV, with a focal length of 20 mm and a telescope with a focal length of 600 mm, which is generally considered to be a short focus telescope. The magnification will be 600 mm/20 mm or x30. The actual field of view you will see in your eyepiece will be the AFOV of 60 degrees divided by the magnification obtained, or 60/30, which is 2 degrees. This is equal to four Moon widths.

The same eyepiece in a telescope of 1,000 mm focal length will have a power of 1,000/20 or 50x and a field of view of 60/50, or 1.2 degrees. Hence the higher the magnification the smaller the field of view. However, an eyepiece design that has, say, 80 degrees APOV and 20 mm focal length will give a power of 50x in a 1,000 mm telescope but give a wider field of view of 80/50, or 1.6 degrees. In the smaller 600 mm telescope the same wide field eyepiece will also magnify at 600/20, or 30x, but give a field of view of 80/30 or 2.67 degrees.

FOV is important because if you start looking for objects with a high power, it can be difficult and frustrating. Always start with a low power, red dot finder or finder telescope, or use a pair of binoculars. Keep practicing, and when you have the object in view, then increase the power if necessary. Low powers also keep the object in the field of view for longer if you are not using a driven mount.

Imaging

This guide is chiefly about visual observing, yet all of the images have been taken by club members from suburban locations, so we include a section on how this was achieved. There are many excellent books, guides and articles on astrophotography; interested readers are encouraged to seek these out and speak with members at local astronomical clubs. Imaging can be quite a challenge, although it is possible these days to take quite impressive shots of, say, the Moon or star fields with modern day smart phones.

Techniques, equipment and software used are described in Chapter 7 and in Appendix A of this book.