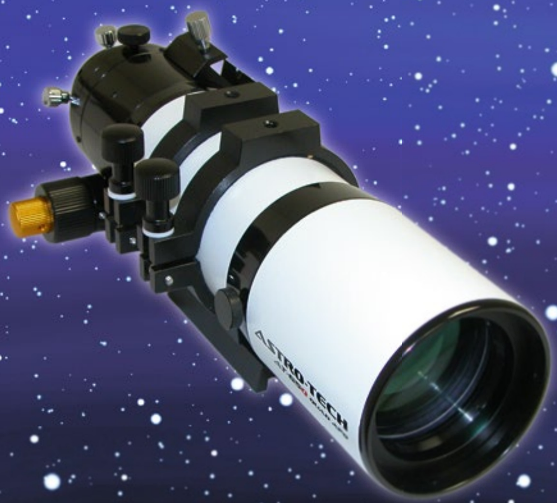
Neil English

Grab 'n' Go Astronomy



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Neil English

Springer

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Fintry by Glasgow
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ISSN 1431-9756 ISSN 2197-6562 (electronic)
ISBN 978-1-4939-0825-7 ISBN 978-1-4939-0826-4 (eBook)
DOI 10.1007/978-1-4939-0826-4
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2014937898

Cover illustration: Cover image used with permission from Astronomics.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Amateur astronomers lead busy lives. After a long day at the office, or looking after young children, the last thing you'd like to do is to drag out a large telescope and have to wait for more than an hour to receive adequate gratification at the eyepiece. This niche is often better suited to a small, grab 'n' go telescope and/or binoculars. In addition, more and more of us are on the move, traveling for both business and pleasure, desiring to bring a small, portable instrument along for the ride.

Or maybe, you're one of the growing army of casual observers, not quite committed enough to own a larger instrument but curious enough to see what a smaller, portable setup can accomplish. Perhaps you live in a high-rise apartment building with limited room to use a large telescope. Is astronomy an anathema? Are you a daytime astronomer, interested only in solar observing? Maybe you're a dedicated lunar and planetary observer, or do you enjoy seeking out the treasures of the deep sky? If your observing schedule fits one or more of the above scenarios, then you need an observing book dedicated to your fastidious needs—enter grab 'n' go astronomy.

After surveying the rich, varied, and constantly changing milieu of grab 'n' go telescopic culture (Part I) and their accessories, this book sets out to demonstrate the amazing things that can be achieved, even with a modest investment.

After surveying the market for small, ultra-portable telescopes, dedicated chapters on solar, lunar, and planetary are presented before delving into the rich milieu of deep sky objects on offer to both suburban and rural observers. The latter will be divided into separate chapters, where we present the full pantheon of celestial objects—including open and globular clusters, emission and planetary nebulae, galaxies, double and variable stars—on show at different times of the year.

The observing part of the book (Part II) is designed to get the observer to think about the objects he or she is viewing. Quite a bit of science is included in the text to help you decipher what you're seeing. In addition, questions have been included to ponder, as well as activities to share in and moments to just pause for thought. This approach resonates well with my conviction that grab 'n' go astronomy can be educational as well as fun to undertake.

Each chapter can be read independently of the other, and the reader is encouraged to dip in and out of the book as and when appropriate. Above all, we hope that this will encourage folk to maintain their interest in observational astronomy and disseminate that knowledge to young people and novice adults alike.

Fintry, UK Neil English
April 2014

Acknowledgments

I would like to thank Alexander Kupco from Ricany, Czech Republic, for allowing me to use many of his fine visual illustrations recorded with his 80 mm Zeiss AS refractor. My thanks also to Stanislas Maksymowicz for permitting me to use his drawings of Venus conducted in daylight. Gratitude is extended to Mike Pearson, an avid astrophotographer from Glasgow, for allowing me to make use of some of his images. I would also like to thank John Watson for turning an idea into a working proposal and the hard working team at Springer, especially Maury Solomon and Nora Rawn, for their expert assistance in the processing of the manuscript. Last but not least, I would like to thank my wife, Lorna, and sons, Oscar and Douglas, for putting up with my long absences from their presence in preparing the material used in the book. Thank you for your love and patience.

Contents

About the Author

Dr. Neil English has a BSc in Physics and Astronomy, and also a PhD in Biochemistry. He is a Fellow of the Royal Astronomical Society and a regular contributor to *Astronomy Now* (the UK's major astronomy magazine), as well as to Ireland's *Astronomy & Space*. Neil's astronomical images have been published in various magazines and journals, including a full page in the June 2006 issue of *Astronomy*. Neil has, and continues to, made contributions to *Cloudy Nights* in the form of several detailed telescope reviews. He is the author of *Guide to Mars* (Pole Star Publications, 2003) and he has a number of books published by Springer, including *Classic Telescopes*, *Choosing, and Using a Refracting Telescope* and *Choosing and Using a Dobsonian Telescope*. Neil currently has (among other instruments) a large 12-in. Dobsonian, which he uses on the darkest, steadiest nights at his home in rural Scotland.

Part I

The Equipment

Chapter 1

Grab 'n' Go Binoculars

Anyone with even a casual interest in astronomy should own a good pair of binoculars. Even avid amateurs with a houseful of telescopes will have at least one pair of binoculars at the ready. And for some activities, binoculars will be all you really need for a lifetime of applications.

It is not unusual for amateur astronomers to begin their work not with a telescope but with binoculars. You'd be amazed at just how much those simple optical accoutrements can extend naked-eye vision. Large open clusters such as the Pleiades look magnificent through them, as does the expansive Andromeda Galaxy (M31) on an autumn evening. The decent light-gathering power and magnification can pull out many thousands of stars in the summer Milky Way that could not be seen otherwise. And watching the changing aspects of the Moon's phases is simply spellbinding.

If your main interest in astronomy is exploring the fine details on planets or showing structure in distant galaxies, you will eventually want to get a telescope, as binoculars just don't have enough magnification (and light-gathering power) to do justice to these objects. However, binoculars certainly have their advantages over telescopes for astronomy, and an ultra wide field of view of them is tremendously desirable. If you're a casual deep sky observer, determined to learn the constellations, or a dedicated comet hunter or variable star observer (discussed later in the book), then good binoculars may be all you ever need.

Choosing Binoculars for Astronomy

There is a bewildering variety of binoculars available on today's market, and it certainly isn't easy to recommend one model over another. The best binoculars for daylight applications may not be the best for nighttime use. Small binoculars are

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DOI 10.1007/978-1-4939-0826-4_1, © Springer Science+Business Media New York 2014

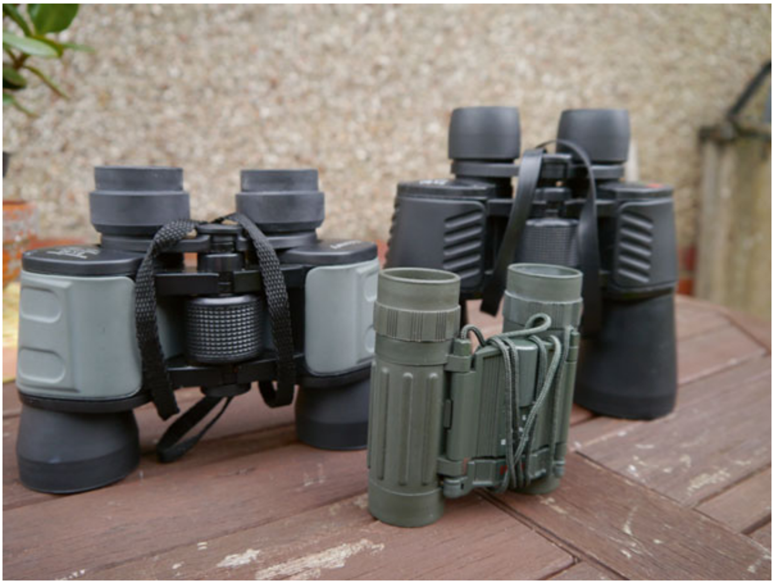

Fig. 1.1 Binoculars are indispensible tools for the grab 'n' go astronomer (Image by the author)

easier to carry about and can be held more steadily in the hand, but larger models can gather more light and allow you to see more details in the celestial objects.

Before looking at a few specific models, let's first discuss the parameters you need to evaluate before making your choice.

Aperture

This is usually provided by the large number printed on the binocular. The larger the aperture the greater the amount of light gathered and the fainter the objects seen. In general, 30 mm is considered about the minimum, but some binocular astronomy enthusiasts employ units with clear apertures as large as 127 mm.

Magnification

The ideal magnification on a set of binoculars to be used for astronomy will differ depending on the way you intend to use it. Most astronomy binoculars have magnifications of between 7 and 15. The higher the magnification, the heavier the binocular will be. Lower powers, although providing wider fields of view are not the best at seeing fainter details. For example, a typical 7 × 50 binocular will be less effective at seeing fainter stars than a model having 10 × 50 specifications.

Hand-Held or Tripod Mounted?

Hand holding a binocular is an enjoyable and less expensive way to enjoy astronomy, with many "normal"-sized binoculars being less expensive than the larger "giant" ones, and there are no accessories to buy; there is the added advantage of no setup time. Also remember that mounting binoculars on a tripod and looking through them is not that practical for viewing positions that are far from the zenith.

Smaller binoculars also have the added bonus in that they are far more versatile, and you can use them for many other applications unrelated to astronomy. If you plan to use this method, you should keep magnification below 12× in order to maintain hand-held steadiness. A good pair of binoculars with a magnification of 7 to 12× and a large objective lens will show you the moons of Jupiter, hundreds of star clusters, nebulae and even some galaxies.

Larger binoculars that can deliver magnifications of between 15 and 30× need to be mounted on a tripod. These binoculars will show more detail and resolve more stars, though they still won't turn your binocular into a telescope. However, there is nothing like the view in, say, a 25× 100-mm binocular to take your breath away on a dark, clear night.

If you are going to use your binoculars for astronomy and don't want the hassle of using a tripod, 7 × 50 binoculars have proven to be a perennial favorite among sky gazers. However sometimes you may want to sacrifice some field of view in order to go deeper into space. In this capacity, a 10 × 50 binocular is even more popular. Most people are just able to hand hold a 10 × 50 for a prolonged length of time and keep the image steady enough for a good view, providing you a nice balance between detail seen and deep sky penetration.

Binoculars with objectives of 60 mm or larger are called giant binoculars, but it is possible to hand hold a 10 × 70 or even an 11 × 80 for short periods of time by grasping them around the barrels near the objectives. Larger objective lenses will reveal fainter stars and probably more detail but will become too heavy to hold steadily for any length of time.

The increased magnification of 10 × 70 binoculars, for example, will add a little more detail to what you can see in a 7 × 50 and maintain the same image brightness as well. So, as far as hand-held binoculars are concerned, 10 × 70 or 11 × 80 represent the upper limit of what is practical for hand holding. For extended use, you will have to go with some sort of mounting arrangement.

Binoculars with magnifications over 15× and objectives of 70–80 mm or more can rival and exceed the view of some small telescopes for certain types of objects, and you get the comfort of using two eyes. The one downside to most giant binoculars is their fixed magnification, though a few models are now available that offer interchangeable eyepieces.

Tripods

Most large, heavy-duty camera or video tripods will work for 80 mm and some 100 mm binoculars. Be sure to compare the weight of the binocular with the maximum load capacity of the tripod, if listed. Unfortunately, this figure is not standardized, nor will it guarantee how well it will work with a large binocular, but it is a place to start.

For 80-mm binoculars, look for a tripod that lists a capacity of at least 12 pounds, but a 15-pound unit will be noticeably better. Another thing to check is the actual weight of the tripod. Light tripods will struggle when loaded with a binocular of equal weight or more. Generally because portability is rarely an issue when it comes to tripods for astronomical binoculars, bigger is always better. Quick-release plates are a convenient feature to look for, but check to make sure they fit very tightly. Loosely fitted binoculars on the tripod head will produce unwanted sag.

Most standard tripods can be used, but because you are looking upwards, it does mean that the eyepieces will be in an awkward position. The best way to get around this is to use a chair and position yourself almost under the tripod. With traditional tripods this can be a little awkward, as the legs often get in the way. Sophisticated binocular mounts, such as the Vanguard Alta Pro, have an adjustable

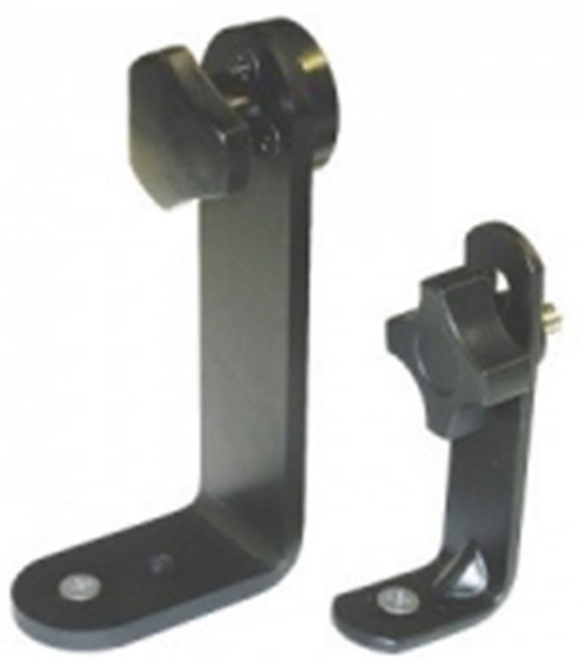

Fig. 1.2 Binocular quick-release plates (Image by the author)

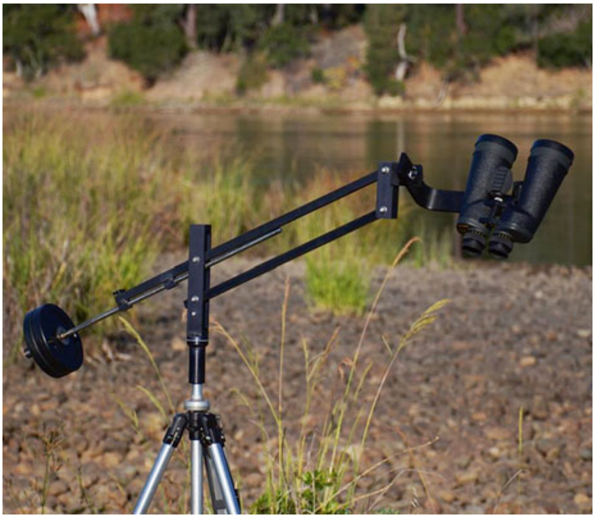

Fig. 1.3 Binocular mounts can be as simple or as elaborate as you like (Image © John Clancy. Used with permission)

central column that you can use to position your binoculars away from the center of the tripod so you can more easily position yourself under your optics. Recently companies such as Orion Telescopes and Binoculars have introduced very cost effective parallelogram mount for $499.

Exit Pupil

Although the size of the objective lens determines to a large degree how much light can enter the binoculars, it does not completely determine how much light enters your eyes, which is actually a more important consideration. A measurement known as the *exit pupil* gives you the width of the column of light exiting the eye-piece and is calculated by dividing the objective lens size by the magnification of the binoculars.

In dark and poor light conditions, the maximum pupil size of a human eye is typically between 5 and 9 mm for people under 25 years of age (with the mean being about 7 mm). This maximum size will also decrease slowly with age. So apart from the very small benefit of ease of use, there is not much point in owning binoculars with an exit pupil larger than your pupil. That said, an exit pupil smaller than your own eye pupil will result in a darker image.

Here's a couple of examples that illustrate these ideas.

For a pair of 7×50 binoculars in very low light conditions, the pupil diameter is 7 mm, so the exit pupil of binoculars will be $50 \div 7 = 7.1$ mm.

Because the human pupil is about the same size as the binoculars' exit pupil, the emergent light at the eyepiece then fills the eye's pupil, meaning no loss of brightness in low light conditions when using these binoculars (assuming perfect transmission). Thus the result is that you will perceive the image as being as bright as if you were to see it with the naked eye.

Now if you were to use much smaller 8×20 binoculars in very low light conditions, the exit pupil of binoculars would be $20 \div 8 = 2.5$ mm. Because the 2.5-mm exit pupil of the binocular is smaller than the 7-mm human pupil, you will perceive the image as being dark.

Thus, for astronomical applications you are looking for an exit pupil of 5 or more; however, with higher magnifications this is not always possible, as the objective lenses would have to be massive. So, although many giant binoculars have slightly smaller exit pupils than ideal, they are still large enough to provide you with a sufficiently bright image. However, this brightness is also determined by the amount of light transmitted by the binocular to your eye.

Light Transmission

Although the size of the objective lens and the size of the exit pupil are very important, they only tell part of the story when it comes to just how well your binoculars will perform in very low-light conditions. As light travels through a glass lens or prism, some light is lost through absorption and reflection at each air-to-glass surface or inside the prism system itself. The amount of original light available to the observer by the time it exits the eyepiece will vary from as low as 50 % to as high as 97 %.

The precise transmission levels are dependent on a number of factors, including the quality and number of optical glass elements used in the lenses and prisms, the configuration and size of the prisms, how well the collimation of the optical system is, the type and amount of anti-reflection, as well as the quality of the coatings applied to the lenses and prisms.

The term used to describe this percentage of light that is not lost through the optical system is *transmittance*. Good quality binoculars will usually have a transmittance level above 90 %, while lesser quality instruments that use poorer quality glass and coatings will be far lower. All things considered, it's possible for a 10×40 binocular (exit pupil 4 mm) with a high transmittance (90 %) to actually deliver a brighter image than a 7×35 (exit pupil 5 mm) with a lower transmittance (70 %). What makes matters worse is that most manufacturers don't publish their binocular transmittance levels, unless they are sure that it outperforms their competitors! So how can you be sure that the binoculars that you get have a high level of transmittance?

To avoid disappointment, it is always best to ensure that the binoculars you are purchasing employ quality optical glass and prisms as well as anti-reflection coatings. An easy way to see how well anti-reflection coatings work is to point the binocular at some bright street lights. After focusing carefully, examine the image for internal reflections. Many budget units fail this test. Look for those that employ BAK-4 prisms and not the inferior quality BK-7 glass. Most modern binoculars have anti-reflection coatings on all or at least some of their air-to-glass surfaces. What these coatings do is to assist light transmission.

It is important to note how the manufacturer describes their coatings, as they are not all created equal. Ideally you would like to see the term “Fully Multi-Coated” stamped on the binocular, which means that all the air-to-glass surfaces have received multiple layers of antireflection coatings. If you just see “Fully Coated” or “Multi-Coated” it means only some surfaces have coatings, or they only have a single coating. The latter will not perform anywhere near as well as fully multi-coated instruments, all other things being equal.

If you plan on choosing a roof prism binocular then you need to look at the kinds of coatings used to increase their light reflectivity. Roof prisms have a number of advantages over Porro prisms, but they do have one surface that does not exhibit total internal reflection. It is therefore very important for the binoculars’ optical performance that the reflectivity of this surface is raised. In most cases, an aluminum mirror coating is used that has a reflectivity between 87 and 93 % or, better still, that a silver mirror coating (reflectivity of 95–98 %) is used. This light transmission of the prism can be improved by using a dielectric coating rather than a metallic mirror coating. A well-designed dielectric coating can provide a reflectivity of more than 99 % across the visible light spectrum. In the less expensive binocular models, an aluminum mirror coating is used, while higher quality units employ silver or dielectric coatings. Roof prism binoculars that lack high reflectivity coatings on the prisms should be avoided.

In the past, a quality giant binocular would be a very expensive purchase, but recently many more manufacturers have been producing astronomy binoculars—many of which are made in China—that has brought the prices down. What is good for us the consumers is that many of the new Chinese optics are now being made to very high optical standards, and while many may not like to admit it, they perform as well as many far more expensive binoculars made in the west. Some popular brands include Oberwerk, which has plenty of nice features, including collimation screws. Other good sources of astronomy binoculars are Celestron, Meade and the excellent Apogee brand. All of these offer fantastic quality for the price and bring giant binoculars within reach of most people’s budgets.

In general, you ought be able to find a quality set of 80-mm binoculars for around $100–300, with 100-mm models starting at about $400. High-end models can cost over $1,000 and come with interchangeable eyepieces and pier mounting options. The best giant binoculars for astronomy are not cheap and are usually made in Japan or Germany. Arguably the finest astronomy binoculars are manufactured by Fujinon, which produces everything from a 70-mm binocular to pier-mounted telescopes. Kowa and Nikon produce great models, too.

Other Features to Consider

Close Focusing Range

Although this is certainly important for daytime observations, it is of little importance when it comes to astronomy.

Waterproofing

There is not much of a need for an astronomy binocular to be waterproof. Only reasonable water resistance is enough, as using them at night can expose a binocular to dew and moisture, which can cause a non-waterproof model to mist up inside the mechanism. In general, better quality binoculars tend to be sealed (nitrogen purged) and fully waterproof as well as fog proof, and so this is one indicator to look out for if you want to make sure that the binoculars you are getting are of a good quality.

Field of View

Although the field of view on astronomy binoculars is not as important as it is for people using their binoculars to view unpredictable, fast-moving objects such as wild animals, it is still fairly important. Field of view is basically the width of the scene that is in view when you look through your binoculars. A wide field of view will make it easier to scan the night sky and find objects when looking through the binoculars.

Everyone talks about magnifications, and there is no doubt that high magnifications yield beautiful views of the Moon, planets and fine detail in some deep sky objects. However, many objects in the sky are too large to fit into the field of view of a high power eyepiece. These objects demand a wide field of view to appreciate their beautiful and delicate morphologies. The other caveat with ‘wide field’ binoculars is that they may exhibit distorted or out-of-focus star images at the edges of the field. The best advice, as ever, is to try before you buy.

Eye Relief

This is the distance behind the ocular lenses where the image is in focus. So if you wear glasses, you can’t get your eyes as close to the lenses, and thus you may need a longer eye relief to project the image beyond the ocular lens on the binoculars.

If you wear eyeglasses, you should be looking for an eye relief of around 15 mm or more, to see the full image. The downside to long eye relief is that it usually reduces the field of view.

Eye cups can affect the eye relief also, as they increase the distance from the oculars to our eyes, but they also help keep stray light away from your eyes while using binoculars. Many eye cups are made from rubber and can roll up or down depending on whether you wear eyeglasses or not. The problem with these is that the constant rolling causes the eye cups to break. Another eye cup design uses a sliding cup, but this can be hard to keep in place. A third type employ eye cups that twist up and down, so they can be left at any position (all the way up to all the way down); some even have click stops at regular intervals with the eye relief distance for each stop marked on the cup so you can get the perfect eye relief for your vision.

Collimation Tests

Thus far, we have tackled the various factors that need be in place before binoculars work optimally, including the types of prisms employed, the effect of anti-reflection coatings and so on. But if the various optical components are not aligned properly—that is *mis*collimation—the user will not be able to use the image and/or field of view will be compromised. Fortunately, there is an easy way to test if the binoculars are miscollimated. Simply hold them up to a bright sky background and examine the shape of the light cone emerging from the eye lenses. It ought to be completely circular. Any departure from circularity is a sure sign that one or more of the components has become misaligned. This is a delicate procedure to fix and so is best performed by a specialist.

Image-Stabilized Binoculars

Image-stabilized (IS) binoculars have been around for over a decade now. Many who use them report an entirely different viewing experience. The image is magnified without jitters, allowing you to relax and enjoy the view rather than having to 'interpolate' the detail. A good pair of IS binoculars will stabilize both high frequency jitters as well as longer period oscillations caused by body movement or platform shake. All this leads to an enhanced experience, almost as if the optical instrument isn't there.

The benefit is much easier to experience then describe. For example, think about being at an airport, watching an airplane take off. As the plane picks up speed, IS binoculars prove indispensible for maintaining sharpness of the image as it shifts in position. Indeed, the view would be utterly impossible without IS. Pick any resolution target, and the amount of detail that can be pulled from the picture is magnitudes ahead of the hand-held view. Even mounted binoculars fall short in comparison. Increased steadiness also makes it easier to resolve finer and fainter detail.

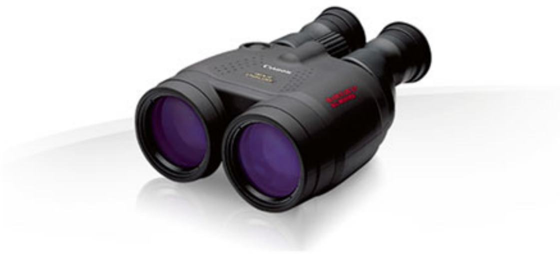

Fig. 1.4 Canon 18×50 IS binoculars (Image © Canon. Used with permission)

So, what are the drawbacks to IS technology? The price is one legitimate objection. That said, prices on many IS are now comparable to mid-priced non-IS units. Many of the top-end manufacturers now make and market a range of IS models. Canon, Fujinon, Nikon, and Bushnell have also done a good job in controlling prices to bring affordable models to the marketplace. Another disadvantage is that IS units are a bit heavier than traditional binoculars, but not excessively so. Certainly the portability is still there. Like all electronic devices, batteries may be required, but typically they don't add much weight, and the cost for a good set of 4 AA rechargeable batteries is not going to kill anyone's budget. Indeed, most units can be used continuously for hours before running out of power. The biggest drawback to an IS unit is its durability, or rather its lack thereof. Its moving parts—gyroscopes and sensors—may not be the best choice if you are going to be expecting hard knocks during rough use. That said, many users are impressed at just how durable IS binoculars are, given the complexity of their designs.

This brief overview of the binocular market should help you get the right kind for your observational program. Good luck with your purchase.

Chapter 2

Grab 'n' Go Refractors

Small refractors—those telescopes that use lenses instead of mirrors—have long been favored as the ideal accompaniment for astronomy or nature studies on the move. Small, lightweight and capable of delivering both low and high power views more or less out of the box, it is no small wonder that a rich array of instruments can now be had, with price tags that range from bargain basement to outrageously expensive.

Refractors come in two distinct flavors: achromatic and apochromatic. Achromatic telescopes use tried and trusted crown and flint glass to bring two colors of light to a sharp focus. These are perfectly adequate for most applications—either terrestrial or astronomical—and are less expensive than their apochromatic cousins, which employ special, low dispersion (ED) glass to focus three wavelengths of light. Apochromats give brighter images and throw up less secondary spectrum (violet fringing round bright objects than their achromatic counterparts. Because of their modern glass prescriptions, apochromats command a heftier price tag.

Good achromatic optics are *much* closer in performance to apochromats than is commonly believed. Indeed, it was with achromatic optics that all the splendors of the heavens were unveiled to the observers of yesteryear. Moreover, achromatic images are qualitatively different to apochromats; the image is dimmer at a given magnification than the apochromatic counterpart and may suit some observers more than others. Indeed, this author has vociferously expressed a preference for achromatic optics and helped raise awareness about the rich astronomical culture they once commanded.

Up until fairly recently, there was only a limited range of spotter-type 'scopes available for consideration. These were rather fastidious in their design, often

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DOI 10.1007/978-1-4939-0826-4_2, © Springer Science+Business Media New York 2014

displaying fixed magnification ranges—frequently only ranging from low to medium powers—and built with an eye to sating the needs of birders and other wildlife enthusiasts. And although these telescopes can certainly be used to good effect in astronomical projects, they are not ideally suited to the task. Over the last decade, many small refractors have been brought to market that can be used with interchangeable diagonals and eyepieces and can thus be employed for a broader range of applications that transcend the usual limitations of both spotting ‘scopes and dedicated astronomical telescopes.

Another great advantage of using these so-called ‘crossover’ telescopes is that they can be purchased as so-called optical tube assemblies, and so you can carefully choose the accessories tailored to your needs. This makes them far more versatile than dedicated spotting ‘scopes. One can choose either a 1.25-in. diagonal or a 2-in. diagonal, depending on the eyepiece you want to use.

Most birders make do with spotting ‘scopes that use relatively lightweight 1.25-in. eyepieces. The 2-in. eyepieces deliver greater fields of view, which is fine for astronomy but normally overkill if you’re trying to concentrate on the variegated feathers of a nesting Robin. By purchasing an optical tube assembly, *you* get to choose the kind of viewing you want to experience. Having observed through traditional spotting ‘scopes for many years, with their dedicated, non-interchangeable zoom eyepieces, you might find this new-found freedom a great liberation.

Small refractors manufactured primarily for amateur astronomy do not yield correct orientation views but a number of companies, including William Optics, produce both 1.25- and 2-in. prismatic diagonals angled for 45° viewing. They were designed to give very good images over typical daylight magnifications for their small ED ‘scopes, like the Zenithstar 66, but the image quality seems to rapidly degrade if powers above 60× or so are employed.

There is a near perfect panacea for this, thankfully, and it is embodied in the form of a high-quality mirror diagonal. In general, its excellent optical flatness and high reflectivity allows you to use much higher magnifications—if your project calls for it—than the 45° prismatic diagonals. The best mirror diagonals have dielectric coatings that boast 99 % reflectivity.

The term ‘near perfect palliative’ is given for a purpose; the only caveat with mirror diagonals is that, although they yield upright images, the view is reversed left to right. What’s more, traditional astronomical mirror diagonals are designed for looking high in the sky and thus are designed with 90° angles. One notable exception is the 1.25-in. Tele Vue 60° Everbrite diagonal. Designed by Al Nagler, this diagonal offers all the comfortable terrestrial viewing of a 45° prismatic diagonal does but delivers noticeably better images, especially during high-power applications. As you might expect, it doesn’t come cheap ($210) either. One birder known to this author uses one with his inexpensive $100 spotter!

Another issue for spotting ‘scope users is minimum focus distance, or *back focus*. That’s the closest distance to an object that your spotting ‘scope will focus on. If you like using your ‘scope as a long-distance microscope, you’ll need to be able to focus at close range, often within a few meters. If the ‘scope you purchase