

Buying the Best Telescope



Buying the Best Telescope

By Alan Dyer

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[Sky & Telescope](#)

Above: There are many different types of telescopes to choose from. Before you rush out and buy, it helps to consider what instrument best suits your needs. All *Sky & Telescope* photographs in this article are by Chuck Baker.

CONTRARY TO WHAT YOU MIGHT THINK, your best choice in a telescope isn't buying the most powerful one you can afford, nor the biggest, nor the one with the most features. The best telescope is the one you will use most often.

A telescope that can be easily carried and set up in moments is one you'll enjoy for many years. Happily satisfied, you'll stay in the hobby and perhaps move to a bigger, fancier instrument later on.



Above: Astronomical telescopes come in all shapes and sizes. This article will help you decide which type is right for you. Shown here, from left to right, are a 6-inch Newtonian reflector from Meade, a 5-inch Schmidt-Cassegrain from Celestron, and an 80-mm short-focus refractor from Orion.

A first telescope should combine simplicity, portability, and ease of use with sharp optics and a steady mount. What fits the bill?

The 6-inch Dobsonian

For most first-time buyers on a budget the choice is simple. The ideal starter scope is a 6-inch (15-centimeter) reflector on a Dobsonian mount. The "6-inch" refers to the diameter of the main, or primary, mirror. In a Dobsonian design, the telescope tube usually rests in a wooden cradle and turns on bearings made of Teflon pads. *Sky & Telescope* test reports have demonstrated the fine value of these entry-level models.

The 6-inch optics gather a generous amount of light, yielding bright, sharp images. Planets appear reasonably crisply defined, and dozens of galaxies and nebulae are bright enough to show as more than dim smudges. While larger instruments will surpass a 6-inch for image brightness, they aren't as portable. An 8-inch Dobsonian is a tempting alternative, but its tube and mount will be bigger and weigh about 30 percent more.



Above: Three Dobs in a row. The Orion Deep Space Explorer, Celestron Star Hopper, and Meade Starfinder Dobsonian (from left to right) offer bright, sharp views, ease of use, and good portability at a relatively low price.

A Dobsonian mount takes little effort to set up. Put the base on the ground and drop the tube into the base. There's no polar alignment necessary and, once the mirrors are collimated, nothing else to adjust. To move and aim the scope, just grab the tube and swing it across the sky. Its light weight and relatively compact size make it a snap to move around a backyard or slide into the back seat of a car. In short, a 6-inch Dobsonian reflector is a fine starter scope, far outperforming the smaller, flimsier, yet comparably priced beginners' telescopes that proliferate in department stores at Christmas.

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Approximate price: About \$350, but count on spending about \$50 to \$100 more for recommended options such as a good finderscope, an extra eyepiece or two, and star charts.

It's Too Big!

There's no perfect telescope and sure enough, a 6-inch Dobsonian isn't for everyone. Perhaps its 4-foot-long tube won't fit into your car and still leave room for the family. Perhaps you live in an apartment and like to observe from your balcony. The long tube, wide swing, and eyepiece height only two to three feet above the ground may not be practical. Or maybe you want a telescope you can easily bring on airline trips.

For ultimate portability there are several choices, all involving some sacrifice of aperture. Compact Schmidt-Cassegrain or Maksutov-Cassegrain telescopes offer 3½- to 5-inch (90- to 125-mm) apertures and optical systems that fold a 48-inch focal length into a tube no more than 12 inches long. The entire telescope will fit under an aircraft seat.

Small is beautiful. Meade's ETX (left) and Celestron's C5 (right) incorporate decent apertures in a compact package.



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Alternatively, short-focus refractors are available in 2.7- to 3.1-inch (70- to 80-mm) apertures with tubes short enough to fit into a camera case. Primarily designed for low-power, wide-field views of the stars, these refractors also work well for moderate-power views of the planets. All require a sturdy tripod at extra cost.

Approximate prices: \$600 to \$1,200 for a 3½- to 5-inch Maksutov- or Schmidt-Cassegrain telescope. \$300 to \$800 for a short-focus refractor without tripod.

Is There Anything Less Expensive?

For many, \$400 on up is too much to spend on a hobby that may be a passing fancy. This is especially true for those buying telescopes for children. A few manufacturers sell simple 3- and 4-inch (75- and 100-mm) Dobsonian reflectors. Compared to 2.4-inch (60-mm) refractors, the usual choice of parents, these small reflectors will provide better views of favorite targets such as planets.

Its size, construction, and ease of setup make a small Dobsonian ideal for a child. The wooden mount provides a more stable platform (and therefore a steadier image) than the wobbly tripods of many entry-level refractors. Wood also lasts longer than the flimsy plastic parts found increasingly on imported 2- and 2.4-inch (50- and 60-mm) refractors, many of which are no more than toys.

A unique and portable product is Edmund Scientific's Astroscan 2001, a 4¼-inch (11 cm) Newtonian reflector in a sealed, ball-shaped tube.



Left: Perfect portability. Edmund Scientific's Astroscan 2001 houses a 4¼-inch f/4.2 parabolic mirror within a molded plastic sphere.

Those on a very tight budget might want to bypass a telescope altogether. In its place consider binoculars. A 7 x 42, 8 x 50, or 10 x 50 model is best. Binoculars show a surprising amount and, coupled with a good set of star charts, can help a newcomer learn the constellations and how to locate scores of interesting objects. This is essential knowledge for using a telescope.

Approximate prices: \$250 to \$350 for a 3- or 4-inch Dobsonian reflector. \$350 for the Edmund Astroscan. \$100 to \$150 for a good pair of binoculars. \$12 to \$45 for a star atlas.

I Want a Telescope I Won't Outgrow

On the other hand, our basic \$400 6-inch reflector may not be enough for you. If you're serious about the hobby and willing to invest more, there's a universe of choices.

For 25 years the 8-inch (20-cm) Schmidt-Cassegrain has remained the most popular instrument for serious amateurs. These models offer generous aperture in a compact package. The optical system provides excellent views of every class of celestial object, from planets to distant galaxies. All manner of accessories are available, allowing owners to expand their interest into fields such as astrophotography and CCD imaging.

Cost-conscious buyers can take heart that even the most expensive Schmidt-Cassegrain uses the same optics as the no-frills unit. Objects won't look any better in the fancier models! But the high-end units offer features such as computerized pointing.

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Above: For a given light grasp, no other telescope is quite as compact and portable as the Schmidt-Cassegrain. Meade's LX10 (left) and Celestron's Celestar 8 (middle) both cost around \$1,000. Both manufacturers offer more expensive models with "bells and whistles" such as beefier mountings and computer-controlled drives. As an alternative, consider the Astro-Physics 5.1-inch apochromatic refractor (right), which combines premium optics with a precision mounting.

A popular alternative to the Schmidt-Cassegrain is the apochromatic refractor. Yes, their apertures are "only" 4 to 7 inches (10 to 18 cm), but these telescopes boast the sharpest optics on the market. Aficionados prize them for their outstanding views of planets, pinpoint stellar images, and high-contrast views of deep-sky objects. As with Schmidt-Cassegrains, manufacturers offer a wide range of accessories. However, per inch of aperture, apos are the most expensive telescopes on the market.

Approximate prices: \$1,200 for a basic Schmidt-Cassegrain with tripod; \$2,000 and up for a premium model with an advanced electronic drive or computer. \$2,500 for a 4-inch apochromatic refractor with altazimuth mount; \$4,000 and up for a 5-inch or larger apo refractor.

I Want to Take Photographs

Our 6-inch Dobsonian is out of the running here. Snapshot photos of the Moon are possible, but for all other forms of astrophotography with a telescope, an equatorial mount is essential. Unfortunately most popular 6- to 10-inch (15- to 25-cm) equatorial Newtonian reflectors lack drives and mounts accurate enough for long exposures. Nor do they readily accept accessories such as piggybacked guidescopes. They are designed primarily for convenient visual use.

Don't try this at home! Astrophotography requires a solid equatorial mount, a precise drive motor, and other accessories.



If astrophotography is in your future consider nothing less than an 8-inch Schmidt-Cassegrain or 4-inch apochromatic refractor. Either way, purchase the model with the best mount you can afford. A solid mount is essential for sharp photos. The mount should be equipped with an electronically controllable drive motor on each axis.

Approximate prices: \$2,000 and up for an 8-inch Schmidt-Cassegrain with heavy-duty mount, wedge, and tripod. \$3,500 and up for a 4-inch apochromatic refractor on a German equatorial mount. Budget an extra \$400 to \$1,000 for camera adapters, a guiding eyepiece, guidescope or off-axis-guider, a declination motor, and electronic motor controls.

I Want to Look at Birds Too

Some buyers have an eclectic interest. They'd like an instrument to serve double duty as a daytime spotting scope to watch backyard birds or visiting wildlife. The popular Newtonian reflector, however mounted, is not well suited for daytime use. Images will be upside down and cannot be easily turned right-side up. A better choice would be a 2.7- to 4-inch refractor or a 3.5- to 5-inch Schmidt-Cassegrain or Maksutov-Cassegrain. All will accept optional image erector prisms.

Avoid dedicated spotting scopes. Their fixed or zoom eyepieces work well for daytime applications but not for the more rigorous demands of nighttime astronomy.

Approximate prices: \$600 to \$1,200 for a 3.5- to 5-inch Maksutov- or Schmidt-Cassegrain telescope. \$400 to \$2,000 for a 2.7- to 4-inch refractor with altazimuth mount and tripod.

I'm Citybound

Urbanites may think they need a special telescope. In fact, our first recommendation of a 6-inch reflector still applies. However, if you expect to observe mostly the Moon and planets -- the objects that show best through light-polluted skies -- then consider an equatorial mount instead of a Dobsonian.

Though harder to set up than a Dobsonian, an equatorial mount offers a key advantage: equipped with a motor drive, it will track an object across the sky as the Earth turns. This is a real plus for high-power viewing of the Moon and planets, which otherwise requires re-aiming several times a minute. Objects stay centered in the eyepiece for vibration-free, hands-off viewing, making it easier to study and see fine details.

A 6-inch reflector on an equatorial mount with a motor drive costs about twice as much as a Dobsonian reflector with identical optics. But the added convenience may be worth it.

Equatorially mounted versions of smaller 4.5-inch (115-mm) Newtonians and 3.1- to 3.5-inch (80- to 90-mm) refractors offer decent views of planets at lower cost, though with less brightness and resolution than a 6-inch reflector. These two categories contain a wide range of models -- shop for ones with the features listed under "What Do I Look For?" below.

At higher cost, 7- and 8-inch Maksutov- and Schmidt-Cassegrains offer equatorial mounts, built-in motor drives, and more aperture for fine lunar and planetary views.

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Approximate prices: \$650 to \$850 for a 6-inch equatorial Newtonian. \$400 to \$600 for a motor-equipped equatorial 3.1-inch or 3.5-inch refractor or 4.5-inch reflector. \$1,200 and up for a 7- or 8-inch Maksutov- or Schmidt-Cassegrain.

I Live in the Country

If you have ready access to dark skies, you may want a telescope that will take special advantage of those skies. That means more aperture! Compared to our base-level instrument, the 6-inch reflector, an 8-inch reflector provides images 77 percent brighter (0.7 stellar magnitudes brighter). Images in a 10-inch are 56 percent (0.5 magnitude) brighter than in an 8-inch. Bright nebulae reveal more details. Globular clusters resolve into thousands of stars. Definite shape appears in many galaxies. Faint galaxy clusters invisible in smaller telescopes appear scattered across the eyepiece. If the sky is dark.

For deep-sky observing, there is no substitute for aperture. An 8- to 16-inch Dobsonian will show more objects than you can possibly exhaust in years of viewing. These instruments can be big and unwieldy, but a number of manufacturers offer break-apart truss-tube models that allow even 12- to 16-inch telescopes to fit into a car or minivan. As a rule, cleverly designed portable models tend to be more expensive than solid-tube instruments of the same aperture.

Approximate price: \$600 for an 8-inch Dobsonian with accessories; \$3,000 for a truss-tube 12- to 16-inch Dobsonian reflector.

I Can't Find Anything!

Even under dark skies, locating targets is the single biggest challenge most owners face. Enter the computerized telescope.

Built-in computers programmed with the positions of thousands of objects are most popular in Schmidt-Cassegrain models, but many other top-of-the-line instruments now offer them. You need to do some preliminary setup when you take out the scope. Then at the touch of a "Go To" button, the computer slews the telescope across the sky to the correct location.

Other telescopes can be equipped with add-on digital setting circles that provide many of the same functions, but without the Go To capability. You move the telescope manually until the computer flashes that the object has been found.

Approximate prices: \$2,500 and up for a computerized 8-inch Schmidt-Cassegrain. \$300 and up for add-on digital setting circles.

I have Limited Mobility

Everyone can enjoy astronomy. Those with limited mobility, however, find many telescopes awkward or impossible to use -- the eyepiece is too high or too low or swings through too great an arc.

For viewing from a fixed seated position, consider a 3.5-inch Maksutov-Cassegrain or 5-inch Schmidt-Cassegrain. When aimed at the southern sky and overhead, the eyepiece stays at about the same position. These telescopes can be placed on a table, allowing a wheelchair user to slide underneath and sit close to the eyepiece.

Approximate prices: \$600 to \$1,200.

I Can't Wait! I Need a Telescope Now!

For those living outside large cities and far from local telescope dealers, many telescopes are available through mail order only. This includes our favorite 6-inch Dobsonian. Also, high-demand models like these are often in short supply, with long delivery times. Buyers wanting an instrument right away for Christmas may need to make another choice.

A suitable alternative in the \$300 to \$600 price range is a 4.5-inch reflector on a solid equatorial mount, or a 3.1- or 3.5-inch refractor on either a good altazimuth or equatorial mount. These popular telescopes are available in a range of models from many suppliers. At lower cost (\$120 to \$250) a 2.4-inch refractor can serve as a modest starter scope if expectations are low -- don't expect to see many details on the planets -- and if you are careful to select a model with features listed under "What Do I Look For?"

Most dealers will stock all these models for off-the-shelf purchases or same-day deliveries. But don't wait until a few days before Christmas to buy -- the better models may be sold out!

Am I Ready to Buy a Telescope?

Few people ask themselves this, but most should. Can you identify the brightest stars? Can you find the main constellations? Can you point to the Andromeda Galaxy? M13? Jupiter? Saturn? Do you know what M13 is? If not, how will you find these things with a telescope? A computerized telescope will still be useless if you don't know an M-object from a planet, or if you don't know enough bright stars to get the computerized mount properly set up at night ("initialized").

Before spending hundreds or thousands of dollars on a telescope, spend \$150 on good star charts, an astronomy guidebook, and a pair of binoculars. Spend time getting to know the sky. Learn where things are and what things are.

What Can I See?

Even the most modest optical aid will provide startling views of the Moon. However, those 2.4-inch refractors with poor-quality eyepieces and wobbly mounts will show little else well.

The better 2.4-inchers and certainly a good 3- to 4-inch reflector or refractor can capture all the popular targets: Saturn's rings, Jupiter's moons and cloud belts, the polar caps of Mars (when Mars is close enough), as well as bright star clusters and nebulae. The larger the aperture of the telescope, the more you'll see.

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Above: Many companies sell small refractors on altitude-azimuth or equatorial mounts, including (from upper left) Tele Vue, Meade, Celestron, and Orion. The higher the optical quality and the sturdier the mount, the happier you'll be with your purchase -- *especially* for such small-aperture instruments.

However, even a large telescope will not show you

- The flags on the Moon -- they're too small!
- Stars appearing as disks -- they're points in even the largest telescopes.
- Nebulae in technicolor -- the Orion Nebula looks greenish, but most nebulae and galaxies are so dim that they appear gray visually.

Is This 400X Telescope Any Good?

The most important specification of any telescope is its aperture, the diameter of the main lens or mirror. Forget power. Forget magnification. If you switch eyepieces any telescope can be made to magnify at almost any power.

The maximum useful magnification is 50 times the telescope's aperture in inches. Under that rule the top power of a 2.4-inch is 120x, of a 4-inch, 200x. Beyond those limits images break down into dim, fuzzy blurs. Even at that, seeing most objects well rarely requires more than 150x. And the clearest, sharpest views will be at a telescope's lowest power, around 8x per inch of aperture. Quality telescopes are equipped not with high-power eyepieces but with good low- and medium-power ones.

Above all, avoid any telescope advertised primarily by its magnification -- for example, "Powerful 400x model!" That's a sure sign of poor quality disguised to lure impulse buyers who don't know any better. But now you do!

What Do I Look For?

- In a word, aperture. But the following features are also hallmarks of a quality telescope:
- A 1¼-inch focuser. Telescopes that accept only the smaller, 0.965-inch eyepieces are almost always inferior. The small eyepieces certainly are, especially ones marked H, HM, or SR. Better telescopes come with Kellner (K), Modified Achromat (MA), or better yet, Plössl eyepieces.
- A true 6 x 30 finderscope (6 power with a 30-mm front lens that is not "stopped down" by an internal baffle to hide poor optical quality). The finder should be mounted in a bracket with six adjustment points rather than three -- it's much more solid.
- All wood-and-metal construction with minimal use of plastic, especially in moving parts such as the focuser.
- A mount and tripod combination that doesn't flex and shake at every touch. Does the telescope move smoothly and precisely over small distances and stay firmly in place when you let go?
- Slow-motion controls on both axes (unless it is a Dobsonian mount).
- On low-cost telescopes, ignore high-tech-looking features such as dials and setting circles. You won't use them.

The manufacturers and dealers who advertise in Sky & Telescope cater to the knowledgeable amateur-astronomy market. Staying with their products will net you a telescope of far better quality than the models made for the impulse buyer.

So I Buy the Biggest Telescope I Can?

No. Spending lots of money on the fanciest or biggest telescope doesn't necessarily get the best telescope. Too many dream scopes end up decorating living rooms or cluttering up garages. Why? A telescope has to be moved. It has to be carried out to the backyard or packed into a car and transported to a rural observing site, then reassembled. Many people's first telescopes, superb as they are in optics and features, are just too big and heavy.

Think twice about buying any instrument weighing more than 60 to 75 pounds. The novelty will soon wear off and excuses will replace enthusiasm.

A Refractor is Better, Right?

Refractors use a lens (actually a matched pair of lenses) to gather and focus light. They are most popular in 2.4-inch (60-mm) to 4-inch (10 cm) apertures. Premium "apochromatic" models in 4-inch and larger sizes use lenses made from special glasses to eliminate false color fringing around bright objects. Refractors provide a rugged instrument requiring no adjustments to the optics.

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Reflectors, on the other hand, use a large primary mirror, which requires occasional collimation adjustments. Newtonian reflectors (named after their inventor, Isaac Newton) employ a small, flat secondary mirror to deflect the light through the side of the tube to the eyepiece.

Schmidt-Cassegrain and Maksutov telescopes are also reflectors, but with an added lenslike correcting plate.

As a rule, refractors provide sharper views than do reflectors of similar aperture. However, reflectors, especially Newtonians, offer far more aperture for the money than refractors. So which is better? A good refractor offers performance; a good reflector offers value.

Don't I Need an Equatorial Mount?

German equatorial mounts are popular on long-tube telescopes such as refractors and reflectors. Schmidt-Cassegrain and Maksutovs often use an equatorial fork mount. When equipped with a motor and polar aligned properly either style of mount can automatically track the sky. This is convenient for visual use and essential for photography.

However, equatorial mounts can be heavy, expensive, and confusing for beginners to set up and operate. Worse still, equatorial mounts supplied with many low-cost telescopes look high tech but are wobbly, ruining the view.

An altazimuth mount may be far steadier and less expensive. Models supplied with entry-level refractors provide up-down and side-to-side motions. The best units have slow-motion controls on both axes for making fine pointing adjustments.

The Dobsonian (named after amateur John Dobson, who popularized the design) is a form of altazimuth mount. These wooden mounts are popular on Newtonian reflectors of all sizes from 3-inch to 36-inch. They are simple to set up, move smoothly even without slow-motion controls, and provide outstanding value. For most beginners, a sturdy Dobsonian mount is far superior to an equatorial mount that is lightweight but shaky, or one that is solid but heavy and costly.

Where Can I Find Out More?

Contact manufacturers and dealers to get all the literature you can, and visit local dealers. Of course they'd like to sell you a telescope, but they're also good sources of information. Keep in mind, dealers hate spending lots of time with a prospect only to have that person buy from another supplier just to save a few percent. If a dealer helps you, give him your business. You may need his personal after-sale service. For a list of vendors of binoculars, telescopes, and accessories, see SKY Online's Marketplace.

Local astronomy clubs often host star parties where you can see various telescopes in action and talk to their owners. See S&T's Astro Directory for a list of clubs in North America and Europe.

Your local planetarium or science center probably has someone on staff proficient in telescopes who can provide recommendations. S&T's Astro Directory (see previous item) lists planetariums and science centers too!

Online services such as CompuServe and America Online, as well as Internet newsgroups, have forums geared to amateur astronomers. Frequently Asked Questions files contain useful tips.

Read, read, read! Go to your local library. Test reports in Sky & Telescope contain detailed information on specific models. Check SKY Online's Test Reports Page for a selection of past reviews.

Alan Dyer is a contributing editor of Sky & Telescope. He is coauthor with Terence Dickinson of The Backyard Astronomer's Guide.

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