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So You Want
a Meade LX
Telescope!

How to Select and Use the LX200
and Other High-End Models

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 Springer

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Rather than merely using my own images I posted a request for contributions and was delighted with the quality of images supplied to me. I regret that only a few could be selected because of space limitations. My thanks to all who responded.

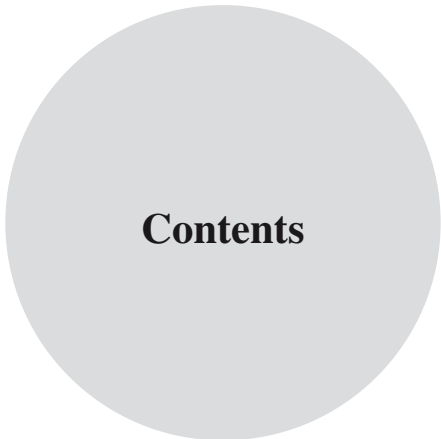
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Any errors that get through, however, are mine.



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About the Author

Lawrence Harris retired from his job as a British government space scientist following nearly two decades at the leading edge of space research. For almost 20 years, Harris has been a columnist writing about weather satellites and space research in some of the top astronomical publications. He has also contributed extensively to astronomical society magazines. Harris is the proud owner of several Meade LX telescopes, including the top end LX400 telescope.

Chapter 1

Introduction

Computers and Astronomy

Perhaps every generation of astronomers believes that their telescopes are the best that have ever been. They are surely all correct! The great leap of our time is that computer-designed and machined parts have led to more accurately made components that give the astronomer ever better views. The manual skills of the craftsman mirror grinder have been transformed into the new-age skills of the programmer and the machine maker. (The new products did not end the work of craftsman telescope makers, though. Many highly skilled amateur/professional opticians continued to produce good-quality mirrors that are still seen today.) Amateur-priced telescopes are now capable of highly accurate tracking and computer control that were once only the province of professionals. This has greatly increased the possibilities of serious astronomy projects for which tailor-made software has been developed. Add a CCD camera to these improved telescopes (see Chap. 3), and you bring a whole new dimension to your astronomy (see Fig. 1.1).

Look Before You Leap!

But first, a word of caution. Unless you are already familiar with astronomy and basic telescopes, it is not wise to start spending large amounts of money on a well-featured telescope. Such an instrument might otherwise be subsequently abandoned due to a perceived overcomplexity coupled with a waning interest. For absolute beginners, many seasoned amateurs would recommend that the first purchase of an instrument



Fig. 1.1 NGC7380 100 min total exposure using a 12-in. (30-cm) Meade LX400 telescope, Starlight Xpress SXV-H9C one-shot color camera, and Starlight Xpress Adaptive Optics unit (image credit: Lawrence Harris)

for astronomy should be a pair of binoculars. A pair of 10×50 binoculars (10 refers to the magnification, and 50 refers to the aperture diameter in millimeters) provides an excellent instrument for an introduction to the hobby. Binoculars are totally portable, so they can be taken into your back garden or to darker skies out of town. Here, they will give outstanding views, showing significantly more than the naked eye, and offer the best visual introduction to the night skies. They should reveal much fainter and often more colorful stars as well as the steady shining light of planets, star clusters, and even an asteroid or two. A vague patch of light resolves, becoming the Andromeda Galaxy; the Pleiades or other well-known star clusters all take on a whole new appearance. Your familiarity with the sky is likely to improve to the point where you can identify the brighter stars and several planets. Binoculars offer the chance to test your interest in the night sky without spending anything more than about \$80. A good star atlas is also helpful!

Advancing from Binoculars

Having had your appetite whetted by at least a trial period with a pair of binoculars, you may well decide to move on and buy an actual telescope. Again, a word of caution here! A decent small telescope – see Fig. 1.2 – that can enable you to see fainter deep space objects and provides a manually controllable mount may cost about \$250. This is surely preferable to the possibility of spending over \$4,000 on



Fig. 1.2 A small refracting telescope on a low-cost mount. This telescope includes a small finder telescope, a right-angled prism, two low-cost eyepieces, a weight balance arm, and manual drives

an instrument that could fail to maintain your interest. An excellent way forward is to chat about your ideas with your local astronomical society. There will always be members that have significant experience using medium-sized telescopes, if not larger ones, and such societies may even be able to offer suitable telescopes on temporary loan. At the very least, you should be able to join others using a well set up scope and to experience its capabilities.

Telescope Types

No matter what price range you look at, any small telescope will be one of only a few types: the refractor, the reflector, and various forms of the Schmidt-Cassegrain telescope (usually referred to as an SCT) that uses an optical configuration that is a combination of a main mirror, secondary mirror, and correcting plate. Another advanced form, the Ritchey–Chrétien design, combines mirrors and lenses to eliminate many of the major optical imperfections often experienced with lesser optics.

Small Refractors

The refractor essentially uses two lenses that refract (bend) incoming light rays, bringing them to a real focus near the eyepiece. Refractors often have long tubes

due to the focal length of the main objective lens and therefore can give the false impression of being powerful. Focal length (and consequent magnification) is often associated with power, although this is quite misleading. The most important parameter of a telescope is its aperture – the diameter of its objective (in the case of a refractor) or the diameter of the mirror (in the case of a reflector). It is this dimension that defines the instrument's light grasp. The larger the aperture, the greater the light grasp. Because the light-gathering power is related to the actual area that collects the incoming light, the telescope power changes as the square of the diameter, so a 30-cm-diameter telescope has four times the light grasp of a 15-cm telescope. This desire to get ever larger telescopes is sometimes referred to as aperture fever!

Refractors can become very costly as the aperture increases, mainly due to the increasing cost of manufacturing high-quality optical components for the main lens. Keen amateur astronomers often use refractors for planetary imaging, although a good-sized reflector can provide an image of comparable quality. Viewing through a high-quality refractor on a good mount can produce an excellent image. A well-aligned, sturdy, good-quality mount is an important factor in obtaining the best viewing conditions with any telescope. Spindly, wobbly mounts are liable to be buffeted in the slightest breeze, causing multiple vibrations to any image and really spoiling the viewing experience. The main limitation in image quality with some refractors is the presence of chromatic (color) fringes or other aberrations. The components of the main lens have to be extremely well matched to fully eliminate, or at least minimize, such aberrations.

Buying a refractor with a basic mount in the \$200+ price range should get you a modest telescope of about 5 or 6 cm diameter that should be a significant improvement to your observational experience. Setting up this type of mount is usually accomplished within about 10 min, and a small collection of useful accessories of nominal quality is invariably provided.

Refractor Accessories

The accessories box usually includes a right-angled prism (this acts as a diagonal mirror) – see Fig. 1.3 – that slots into the near end of the telescope where the eyepiece would normally go. The observer can then view in a more comfortable position rather than contorting to view through the eyepiece at the rear end of the telescope – especially when viewing something high in the sky. This particular box includes a small finder and three eyepieces. Such a finder, designed to fit on the tube, usually comes with even the smallest scopes and should be adjustable for alignment with the main tube. A Barlow lens (used to increase the magnification of an eyepiece) may also be included. It should be understood that at this level, the optics of each component are probably adequate but unlikely to be sparkling. It is likely to be an introductory scope with some basic facilities to make using it fairly easy.



Fig. 1.3 The accessories that come with a small telescope usually include a right-angled prism. This enables the astronomer to view the heavens in a comfortable position rather than getting a cricked neck

The telescope manual should describe basic astronomical principles and how they apply to the setting up and alignment of your telescope; it might even include simple polar alignment. By alignment, we are referring to the need to set the telescope's main rotation axis parallel to Earth's own polar axis so that the telescope can be driven by motor to keep pace with Earth's rotation. The main operational difficulty likely to be found with this type of low-cost scope is the fairly small field of view. Although giving good views of the Moon, any attempt at finding galaxies or other small targets can be daunting; however, it does enable you to discover whether you want to move on with your interest in practical astronomy or settle down to a life in the armchair with a book instead. Do seek advice and suggestions from your local astronomical community.

If your interest in active astronomy develops, a basic telescope can quickly lose its appeal, and you may soon decide to upgrade. You can probably sell such a scope via various specialist Web forums or via your local society. By the time you have developed a serious interest in observing, you can decide on the option of simply spending more cash on a much better scope or trying out better scopes via your local astronomical society with a view to possible later purchase. Inevitably you are likely to appreciate the potential of a better scope, and aperture fever can set in! Discuss your thoughts and ideas with fellow astronomers. This might be at the local astronomical society meeting or better still at a star party. If your luck is really in you might get a chance to see and try a good amateur telescope owned by an enthusiast. This person will be able to tell you far more than a chat with a dealer might reveal. Many specialist dealers are also keen astronomers, and you might meet up with them at a star party.

Reflectors

Aperture for aperture, reflectors are usually cheaper than refractors. The most common design is the *Newtonian* reflector; this incorporates a small secondary plane mirror that reflects light from the primary mirror, off-axis into an eyepiece. For apertures of above 10 cm, the cost of producing a quality parabolic mirror (the shape of a properly designed telescope mirror) is far less than that of producing a quality combination achromatic lens. The cost of an accurately ground 25-cm mirror is but a fraction of the cost of an equal-sized good-quality objective. Because of their relative cheapness, amateurs tend to move to reflectors when they decide to buy a better and larger telescope. As with many experiences in astronomy, the better the mount, the better the resultant image is likely to be.

You may decide to advance directly from binoculars to a medium-sized scope, in which case you are likely to be told by other amateurs to consider buying a 15-cm (6-in.) reflector – see Fig. 1.4. This is often considered to be an ideal size for a first, more capable, telescope: the aperture is sufficient to see quite deeply into space, yet the scope is light enough not to require heavy, expensive mounts. The term *deep space* is used to refer to objects at increasingly large distances from our own planet, often extragalactic objects that are exceedingly faint. With such a telescope the heavens open up to you. The planets lose their mysteriously taunting tiny spherical appearance, as revealed in lesser instruments, and show detail – probably more than you may realize at first glance. Hundreds of asteroids become identifiable; lunar observations take on a far more serious meaning, and far fainter galaxies come within your grasp.

Also coming into the range of medium-sized scopes is the 8-in. (20-cm) reflector, especially in the form of the SCT (mentioned earlier). Because of the considerably greater facilities offered by these scopes, they are priced toward the higher end of the price range of medium-sized scopes.

Moving On Up

So far we have introduced a possible sequence of events; it starts with getting your first pair of binoculars, on to a basic telescope, and to realizing that you want to move on to an even better observing experience. A glance at the brochures and Web sites (see below) of various telescope suppliers reveals useful information. First, there are many individual telescopes and mounts in each price range, all catering to the beginner, the enthusiast, and the advanced amateur. Second, you may find that a specific telescope and mount combination is often available at marginally different prices from different vendors. They may charge according to the after-sales service that they offer; consequently, a general store price may be cheaper than a specialist outlet, but you may wish to inquire about possible technical support after purchase!



Fig. 1.4 Bresser Messier N160 6-in. (15-cm) reflector. This is a very popular size, combining portability with observing capability (image courtesy: Telescope House, UK)

Telescope Suppliers' Web Sites

Some United Kingdom Suppliers

<http://www.iankingimaging.com/>

<http://www.scsastro.co.uk/>

<http://www.sherwoods-photo.com/>

<http://www.telescopehouse.com/>

<http://www.telescopesaes.co.uk/>

Some US Telescope Suppliers

<http://www.celestron.com>

<http://www.meade.com/dealerlocator/index.html>

<http://www.skywatcherusa.com/>

Enter the Goto Handbox

Many telescopes costing more than about \$900 now include a *goto* facility. This involves a small computer often located in a handbox, or a keypad, plugged into the telescope's mount – usually via a standard connector. The manual tells you how to power up the mount, and then the handbox asks for the scope to be aligned, as a basic requirement. Depending on the capabilities (and therefore price) of the system, you have to enter some basic information that might include time (unless there is a built-in clock to remember it), whether you are using UTC or local time, and your longitude and latitude. Once these parameters have been entered, the next stages for the user will involve a polar alignment followed by a star alignment using one, two, or three stars. The experienced amateur soon masters these tasks, and for advanced larger telescope users, there is software available to aid both star alignment and polar alignment. More advanced telescopes often require less start-up intervention, as we shall see. The LX400 is first powered up, then its self-identification GPS location is measured, and it then stores the position where it was left pointing before power-off. Consequently, it is virtually ready to go within a minute or two of power on.

Star and Polar Alignment

At the beginning of a session when you start aligning this type of telescope mount, you have to accurately point the telescope at one or more known (and easily recognizable) stars as requested by the handbox. The box can then synchronize its database to your sky. Most handboxes include a database containing the known positions of tens of thousands of bright reference stars, galaxies, and other targets. Better accuracy can easily be achieved using three-star alignment, rather than the far quicker one-star option. However, *goto* accuracy relies on good polar alignment as well. This latter process is often performed using *drift alignment*, which is described in a later chapter using real examples.

The whole mathematics and physics of computing star positions for driving your telescope relies on the computer calculating positions that may assume that your mount is horizontal and has an axis pointing to celestial north. Some degree of error in these parameters can be tolerated, but the more accurately they are set, the better should be the actual pointing when you activate the *goto* facility.

As discussed briefly, a beginner's telescope with a basic mount can be bought within the price range from perhaps \$150 up to \$400, depending on any offered additional facilities. The inclusion of a motor drive on one or both axes will have a marked

effect on both usability and price. Of course, you can also consider buying second-hand. It is surely much better to spend a nominal amount now, rather than discover a loss of interest after spending several hundred dollars on something more advanced.

Mid-range Scopes

Even astronomers with high-end scopes usually keep a mid-range scope for wide field imaging or viewing. A larger scope cannot provide a wide-field view of large galaxies – unless a camera is mounted on the main tube pointing at the sky with a telephoto lens attached! Good advice before buying a new mid-range scope is clearly essential here. You need to know exactly what you plan to use the scope for before you commit serious money to buying one. There is a huge choice of makes, designs, quality of optics and construction, features of operation, sturdiness of mount, and ease of use. There are entire books devoted to the purchase of this range of telescopes.

When lunar eclipses are in the news, or perhaps a new, bright comet (and there were a number of these during 2005–2008), you may prefer to use a small refractor such as that illustrated in Fig. 1.5. This did not come with its own eyepiece, although one or two other accessories were included. With a good focusing mechanism built-in and a standard eyepiece fitting, it forms an excellent mid-range scope and is also suitable for autoguiding a main telescope.

One can easily acquire small telescopes from second-hand sales at a local astronomical society meeting. They may not be suitable for guiding a main telescope. These are best suited to use as nominal viewing scopes because focusing facilities may be limited and insubstantial – quite unsuitable for fitting a small camera. It is a good idea to buy a quality mount for such telescopes. Do your research. It is important to ensure that you specify the exact requirements that you have for your mount in order to avoid any misunderstanding with dealers. A mount such as the *HEQ5* with *SynScan* handbox – in its final form provides the computer facilities that many find essential – see Fig. 1.6.



Fig. 1.5 An 80-mm refractor: ideal for wide-field views, when fitted to a suitable equatorial mount. Note the small CCD camera fitted to the eyepiece end of the telescope. In my case this is used for autoguiding (see later)



Fig. 1.6 The *HEQ5 Pro SynScan* mount with handbox controller

Wedges for Imaging

Although not essential for visual astronomy, a wedge is essential for imaging – see Chap. 3 on accessories. It allows the telescope to be tilted at an angle that, when equal to your latitude, allows the telescope to be driven on one axis only, instead of the two that would otherwise be required. Once carefully polar aligned, the mount should track reasonably well with any mid-range scope tubes fitted. Wedge adjustment facilities on these mounts are basic, as one would expect, but they should prove adequate for the job. The built-in software is an important consideration; this version can be updated by downloading firmware from the appropriate site. The handbox includes a large database of objects, but the main capability is the option to connect it to a computer for control by third-party programs. Most importantly, it can be controlled by *Maxim DL*, giving it huge versatility – see Chap. 5.

As with all mounts, a set of instructions is provided to aid the setting up of the tripod, the fitting of the balance weights, preliminary adjustment of the wedge to your latitude, and the operation of the handbox. Ensure that whatever mount you buy, the tripod legs are set on a firm surface. If soft grass is used,

it is likely that the legs will sink into the ground to some extent, due to the combined weight of the scope plus equipment. It is possible to prepare a firm base even in soft ground. Dig holes where the tripod legs will rest, and fill the holes with stones, topped up with concrete. Small quantities of concrete are not expensive; a bag of ready-mix can be bought. Alternatively, lay a concrete base for the whole mount – an ideal solution. A firm base makes all the difference to ensuring good tracking following your extensive efforts to align the telescope.

The handbook included with this *HEQ5-SynScan* version has a fairly comprehensive menu for both initial setting up and optimizing, as well as routine observing. The unit also includes periodic error correction (see Chap. 6) and the option for autoguider observing. It is a common practice to mount a guide scope on the main scope and have the guider provide frequent position corrections to the mount.

The Importance of a Balancing System

With the mount should come a balancing system, normally one or more heavy weights that slide along the main axis – see also Fig. 1.6. Depending on the telescope design, the declination axis is usually balanced by suitable positioning of the main telescope fitted with either a camera or the eyepiece unit. Balancing is accomplished by cautiously releasing each locking control in turn, ensuring that there is no resulting violent swing. Adjusting the positions of the equipment can then be done. When properly balanced, the telescope and ancillary equipment should remain stable in virtually any position. It is acceptable to have a slight imbalance on the RA axis toward the east because the motors will drive westward at sidereal rate. A slight imbalance ensures continuous contact with the drive mechanism. Similarly, the declination axis can be left very slightly biased in either direction (up or down). Any residual significant moving tendency will probably strain the motors and should be avoided.

Equatorial Head

The equatorial head allows the fitting of a metal plate on which can be mounted the main scope as well as a smaller guide scope. The latter, as will be explained in detail later, can be used to monitor a guide star (which is not necessarily the target of the main scope) and to detect any tracking anomalies produced by the mount's imperfect gear train. These anomalies are registered on a separate guide camera, and corrections derived by the software are then fed to the mount's autoguider input. These small corrections help to keep the main target centered in the main scope, the process being designed to produce a sharp image. In Chap. 7, we explain the detailed process of calibrating and running a guide scope with the LX series telescopes.

Autoguiding Accessories for Imaging

Clearly, a telescope that offers the ability to autoguide is capable of producing significant astronomical images, rather than merely snapshots of a region of the sky. To do so, you need to buy a guide scope, such as that shown in Fig. 1.5, so anticipate adding this to the cost of producing high-quality images. Also allow for the extra cost of a guide scope CCD camera – see the unit fitted at the eyepiece end of Fig. 1.5 – though these are now available at competitive prices. Another important consideration at this stage is compatibility. If possible – and it usually is – try to buy the whole CCD camera assembly at the same time. Many CCD cameras are now fitted with a facility either already incorporating a guider or with a connector for a proprietary cable for connecting to a proprietary CCD guide camera.

Your Ideal Scope

As your experience of using a larger size of telescope increases, you will realize that several routine tasks could be made easier. Focusing, collimation, polar alignment, and date and time entry – these are a few of the tasks that must be checked before any real telescope success can be achieved, unless you are simply looking through the eyepiece! To have the telescope fulfilling its potential, almost everything must be set correctly. The more advanced telescopes incorporate facilities to make many of these tasks easy – or at least tolerable! A summary of these processes is given below, with more detailed operational descriptions in later chapters.

Time/Date Latitude/Longitude Entry

The telescope's computer has a built-in database that needs to be synchronized with the actual sky if you wish to use the facilities such as *goto*. With the telescope powered on, the handbox will request basic data entry. First enter your time/date and latitude/longitude where requested. Other parameters, as described in the telescope's manual, may be requested. One further entry – pointing it to at least one known star – is usually enough to fully synchronize your telescope.

Focusing

Focusers come in various forms, and their effectiveness will relate to the cost of your scope. There are simple mechanical types in which the eyepiece rack is moved backward and forward along its optic axis until good focus is achieved. Better telescopes