Chapter 2

Meade LX200GPS/ LX400 Series Telescopes

Getting Started

This author's own experiences with the LX200 series scope stretch over many years, starting with the purchase of a 10-in. (25-cm) LX200 (subsequently called the Classic) in 1992 – see Fig. 2.1. The picture shows the telescope mounted on an equatorial wedge inside his observatory. It was one of the early models. This chapter reviews the capabilities of recent medium-sized LX200-ACF telescopes (as the new models are now called), together with the enhancements offered by their companions in the LX400-ACF range (what was originally called the RCX400). The new letters ACF mean *advanced coma-free* optics. In later sections and in the next chapter, we also describe accessories thought to be essential.

The process of unpacking and assembling your telescope is fully covered in the telescope's manual, which should also include any recent modifications. The manual provides a description of many of the things that you need to know for successfully setting up the telescope, together with the necessary safety warnings. More advanced procedures are explained in this book.

What's in a Name?

The LX200 series scopes have endured various name changes over the years. The original LX200 was called the Classic and was followed by the LX200GPS when the GPS receiver was added. Improvements to the optical coatings and further enhancements were indicated by the additional letters SMT, followed by more

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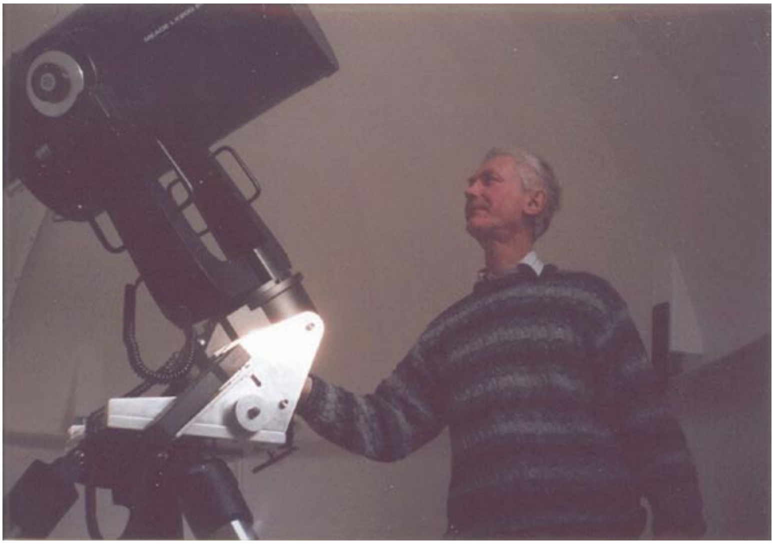

Fig. 2.1 A 12-in. (30-cm) LX200 Classic mounted on an equatorial wedge in Southampton back garden observatory with proud owner

name changes: /R and more recently ACF have indicated later modifications to the range. Here, we are adopting the following nomenclature:

LX200, LX200GPS, and LX400 as generic names
The LX200 is the Classic
The LX200GPS covers LX200GPS SMT – SCT/R/ACF
The LX400 covers RCX400 and LX400-ACF

During the early preparation of this book Meade announced changes to the RCX400 telescope range. Significantly, for legal reasons the name was changed to LX400-ACF (*Advanced Coma-Free*). It was decided that only the larger models – the 16 in. (40 cm) and 20 in. (50 cm) – would be manufactured in the future. However, there are still many smaller sized models (the 8, 10, 12, and 14-in.) in operation. Corresponding telescopes in the LX200 range were renamed LX200-ACF. The ACF models include the improved optical system originally designed for the LX400 scopes but remaining with f10 optics. In this chapter the terms LX200GPS and LX400 refer to the different scopes, both having ACF optics. The original Schmidt-Cassegrain telescope optics are found on thousands of older scopes in the LX200 series.

Meade LX200GPS and LX400

If you have been involved in serious computing, it is natural to want to apply that expertise to your telescope. Alternatively, if you have been using mid-range telescopes and found them a little limiting for your ambitions (as intimated in Chap. 1), you may have studied the market to find out what high-end equipment is available. The advent around 1992 of the computer-controlled Meade LX200 (Classic) series telescope and its sturdy mount was therefore a natural progression for many people. Recent versions have continued to add improved features, such as the focusing mechanism. A first experience of focusing with the LX200 will involve manually turning the focus knob and discovering that with such a design, the image being focused moved vigorously toward the edge of the field. This may be unexpected, so you have to master the art of focusing an SCT while periodically moving it slowly in right ascension to retain the image within the field of view. A regular manual winding of the focuser fully in and fully out helps to distribute the grease along the focuser shaft and consequently helps minimize *image shift* – as this movement is called. This still applies, as does doing a grease dispersal routine every few weeks. Another focusing hint: try to make your final focus twist a push so that the mirror moves away from the rear of the scope; this helps minimize focus backlash that might otherwise let the mirror sag. You also have the mirror lock facility to further improve this.

An electronic focuser add-on was a near essential accessory. The accumulating cost of accessories quickly leads one to realize that the owner does not merely pay for a telescope! Recent models in this series incorporate a microfocuser that largely eliminates the image shift problem.

Within a few months of buying the telescope, at the approach of autumn, you discovered the vulnerability of SCT corrector plates to condensation! Various devices were used to maintain a clear corrector plate. A dew shield is likely to be necessary, particularly in regions prone to high humidity. Light pollution may be severe, and a dew shield can shade the optics reasonably well in many cases. This also helps to limit the onset of dew, though only marginally. An electrically heated band to wrap around the front end of the tube prove – another essential purchase – the *Kendrick* system (see Chap. 3) being a good example.

LX400 scopes are considerably more advanced, having an additional set of focus motors in the optical tube assembly (OTA) – see Fig. 2.2 – apart from numerous other useful features. The focus feature provides precise handbox adjustments to both focus and collimation, insuring the ease of obtaining the highest quality imagery. The corrector plate does not have collimation screws because of this electronic control. Because of the extra motors these telescopes are much heavier than their predecessors (the LX200 series). This chapter takes you from opening the box, insuring adequate power supplies, understanding the importance of initial balance and alignment, through to Meade's *Smart Mount Technology (SMT)* feature (explained later). Actual detailed descriptions of balance, polar alignment, and other processes are discussed in later, separate chapters.

What You Get in the Box

Because this book deals in detail with the advanced Meade LX200GPS (and includes personal experiences with the top-of-the-range LX400 model as well as

Fig. 2.2 The front end of the 30-cm LX400 showing the corrector plate. Focusing is achieved by motors driving the corrector plate within the OTA

many years with earlier LX200 models), let us assume that you have taken delivery of one of these fine scopes! You have (hopefully) already studied the online manual that can be downloaded from Meade's Web site in advance of delivery (http://www.meade.com/manuals), and so know exactly what you have bought – and even how much it weighs! The box packaging includes a printed manual, and there are other boxes that house the various optical components such as the large, heavy eyepiece and the right-angled diagonal mirror. Although the LX400 comes with software on a CD (the essential Meade LX400 USB driver and *AutoStar Suite* software), the LX-series scopes currently exclude this. However, this *AutoStar Suite* can be downloaded directly from Meade's site. The LX400 includes a USB connection cable. The finder and mounting components are carefully packaged as well. A tip: take some pictures of the layout of the boxes and the positioning of their main components (see Fig. 2.3). If you ever have to re-box the telescope for sending back to Meade or your dealer for repair, you could find these pictures invaluable!

The 12-in. LX200 (Classic) is at the limit that most people can manage to carry, keeping in mind that it is often used on an equatorial wedge and therefore has to be lifted higher and at an awkward angle. You may have some heavyweight friends who can do this job, available from the local astronomical society, but be careful here. Do not risk any of your friends or neighbors damaging their backs on your behalf. Hire someone if you have to. Some people are trained in the art of lifting heavy objects.

The telescope manual describes in detail how to assemble the scope and orientate it prior to mounting. Ensure that you understand exactly what has to be done with the various accessories before construction. If you assemble the scope in an observatory, you can do this without major concern about the weather. My first 10-in.

Fig. 2.3 LX400ACF accessories box as first opened. The package includes the handbox, finderscope, right-angled prism, cables, and assorted adapters. A picture can be very helpful should you need to repack for transport

(25-cm) LX200 was for outside, uncovered use, and so the weather was a major consideration. An interest in weather satellite monitoring provides an excellent method of seeing live weather data that can help personal forecasting (see Chap. 10).

LX200GPS and LX400 Connector Panels

On the standard LX200GPS telescopes there are no USB connectors; all commands are sent to the scope via the RS232 ports, as shown connected in Fig. 2.4. The front connector panel of the LX400 telescope is different – see Fig. 2.5 – offering a USB connector. The rear of the LX400 optical tube assembly – see Fig. 2.6 – is also unlike that of the LX200GPS series scopes. There are three USB connectors (seen in Fig. 2.6) that access the built-in hub; these offer direct connection for the CCD camera that you will surely wish to use. One caveat here: long experience indicates that in colder temperatures (possibly below 5°C) the built-in hub becomes unstable. Although for most sessions you can reliably use this connection to save the long USB run from camera to computer, under low-temperature conditions error messages announcing the loss of connection can interrupt an imaging session. If you are planning on leaving the telescope under full automation overnight, as described in later chapters discussing advanced software, consider the alternatives. Many astronomers successfully use an external powered USB hub. Another wiring option is that of a direct cable run to the computer.

Fig. 2.4 Front panel of the LX200GPS telescope. The electronic focuser connection is to the right of the power connection; other connectors (*left to right*) are for the handbox, serial connectors (RS232), and the autoguider port

Fig. 2.5 Front panel of the LX400 telescope. Connectors left to right are for USB, auxiliary connection (*see text*), main handbox, and a serial connector

Fig. 2.6 Rear view of the LX400 showing handles, cooling fan, central visual back seal, and OTA connector panel

For visual use, a reticle connector is available to plug in a reticle eyepiece lead to provide power for the reticle's built-in cross wires. A second handbox connector is available on the LX400 OTA, though it is hard to imagine any circumstances in which it could be useful. The RS232 and autoguider inputs are ideally located; use the autoguider input for direct input of correction signals from whichever system you are currently using for autoguiding (see Chap. 7). The smart accessory connector is a feature reserved for the large *MaxMount* (40-cm and 50-cm models).

The Equatorial Wedge

No wedge is included with the telescope unless you specifically order one. Let us review the decision about whether you are likely to want to use a wedge in the first place. If you are a purely visual observer, the good news is that it is not really necessary to install a wedge. When used in the basic alt-azimuth mode and fitted with the supplied eyepiece, the telescope is well balanced in both altitude and azimuth. The only consideration for the visual observer is that objects will not normally be orientated north to south in the field of view. As the telescope slowly rotates on its axes, the object and field appear to slowly rotate within the eyepiece view. This is not really a concern, though it does result in planetary satellites – such as those of Jupiter – not usually being viewed in the horizontal plane. The various special functions of the telescope, including focusing, collimation, *goto,* etc., all operate exactly as they should, assuming that the telescope is set up for alt-azimuth mode!

Additionally, there is no need to do any PE (periodic error) measurement or correction. Even a scope with poor PE (see Chap. 6 for a full explanation of this) will show hardly any movement as far as the eye is concerned! However, if your plan has been to stick with purely visual observing you would not really need the advanced features of these high-end scopes. Other, cheaper models having an identical aperture would surely be more than adequate.

For those wanting to specialize in astroimaging, there are two possibilities. An equatorial wedge – see Fig. 3.2 in Chap. 3 and Fig. 4.1 in Chap. 4 – is an excellent, almost essential device for converting your dual-purpose telescope into a fully functioning imaging scope. Before that desirable status can be achieved, however, you must go through the process of balancing and polar aligning your telescope. Also covered in detail later is the initial setting up of the equatorial wedge.

Field Derotator

The other option, particularly for those living near equatorial regions (where low latitudes make it exceptionally impractical to use an equatorial wedge), is a field derotator. This device integrates with your scope's *AutoStar II* computer to enable imaging with the scope in alt-azimuth mode. The scope does not therefore require an equatorial wedge when used this way. The *AutoStar II* calculates the amount of field rotation during an alt-azimuth imaging session based on the region of sky being imaged. It then rotates the field derotator and attached camera in the opposite direction in order to precisely compensate for the field rotation.

The advantages of a field derotator include less additional weight (than a wedge) for field use and less time needed for polar alignment. You can also image any part of the sky with the field derotator. However, the equipment stack (flip mirror system and camera) at the rear of your scope might be too long to pass through the drive base of your scope when used near the zenith. The backlash experienced when crossing the meridian can also be a problem. Another reported problem is the difficulty experienced when using PEC – the periodic error correction built-in feature for use in polar mounted scopes – in alt-azimuth mode. Although PEC is (technically) available, many consider it to be ineffective in this mode. Telescopes with poor periodic error may not be able to provide acceptable long-exposure images. Chapter 6 looks at the measurement and correction of periodic error.

Before deciding on whether to buy a wedge or a derotator, you have to consider the advantages and disadvantages to you and then decide which way to go. A large majority of astronomers seem to opt to install an equatorial wedge.

For our purposes, let us assume that you have followed the manual and have mounted the entire optical tube and fork assembly directly onto the tripod. If you wish to mount the telescope directly onto a wedge, you should first read the section in Chap. 4 devoted to setting up your wedge. Either way, let the excitement commence!

Power Considerations

The next major consideration following the heavy work of mounting the scope is powering it up. Depending on your exact model – and therefore its power requirements – it is essential that you obtain and use an adequate power supply. Many of the Meade scopes come with a battery compartment, and the manuals imply that the scope can be run using a number of battery cells. Consider accepting the wisdom of engineering, other experts, and long-time users on the LX forums, and – instead of internal batteries – either use an adequate external battery (which also makes the scope portable as well as providing a clean supply) or use a fully regulated main power supply of adequate power, such as a 10 A power supply (PSU). Beware of recommendations for power on a telescope supplier's Web site. Without enough power there could be immediate problems with the focuser, memory, and even simple driving tasks. The LX400 in particular requires the availability of heavy power and a minimum of 10 A. Do ensure that any main power supply is adequately clean, electrically speaking. A noisy supply can adversely affect the scope.

Caution: It is essential to insure that your supply has reverse polarity checking as well as suitable fusing. It appears that the scopes have no built-in protection against these problems. For the very first use of an LX scope, it seems eminently sensible to set it up for visual use using the supplied optics. This has the benefit of insuring that the scope is already nominally balanced. In this configuration it is perfectly safe to test virtually all of the scope's features. The manual shows where the handbox is connected and mentions the availability – in the case of the LX400 model – of a second connection socket on the back of the OTA itself (see Fig. 2.6). Special care must be taken at the time of first power up, as explained in the manual. At this time, on selecting *autoalign*, the scope – whether LX200GPS or LX400 – is programmed to swing around seemingly at random, although this is, of course, following a preset sequence. On that first power on, you might watch your LX400 drive to various positions using its activated sensors to identify north and horizontal. When it finally finishes this initial alignment, it "knows" where it is and the exact time (using the built-in GPS receiver) and therefore calculates that it is no longer in its place of manufacture, Irvine, CA. The manual describes the process of editing in your own locality name for future reference, and this is straightforward.

Needless to say, this initial alignment process might be different on your scope. The development of increasingly sophisticated software and firmware may result in a change of initial alignment operations. It is essential that the instructions in the manual are read carefully before the first power on. Later, when the *AutoStar II* (telescope) software is investigated, you may find that there are discrepancies between the contents of the manual and the actual command sequences provided! These differences are occasionally discussed on the forums.

Sun Warning!

Much of your initial testing can be carried out during daytime. In that case, you should leave the end (corrector plate) cover on because it is *imperative* that both the telescope OTA and the finder have their covers securely fitted. Under no circumstances should the Sun be allowed to enter either optical system. The intense heat and light could severely damage the scope and might have other unexpected consequences. Following the power-on test, you can at least confirm that nothing untoward happens. You could also set up your computer to connect with the scope during this initial test session. However, you are unlikely to be able to synchronize the scope with any astronomical object, and it is not important to be able to do so at this stage.

GPS Receivers

Once the telescope has completed the initial self-alignment process, you should also see the self-check of the position of the index mark used to synchronize the scope's PEC table (which will be explained later). During the process that follows power on, the telescope mount drives approximately 24° westward, as described in the manual. A worthwhile action here is to use the handbox *setup* option to switch the GPS receiver to receive *GPS at start-up*. It will then, in future, cause the scope to seek GPS satellite data after power up, insuring that the scope "knows" the precise date and time. This information is not stored on the scope. If the PEC table has been activated (see Chap. 6) *and* the scope previously *parked*, it will not need to do this westward drive each time it is powered up. If you are in a poor reception region for the GPS satellites, or if you prefer, you can disable the GPS receiver and manually input the time yourself at every power on.

One possibility here is that the GPS receiver could fail to achieve a fix during this first time. You can try loosening the RA clutch and moving the tube to see whether the GPS receiver can get a better fix. If you are not prompted for your site, then the scope may remain set for Irvine. In that case you should manually *edit* your custom site using your – at least approximate – coordinates. It is also essential to *edit* – if not performed by the GPS fix – your time zone. Be aware that both LX200GPS and LX400 use negative values for the difference from GMT for longitudes west of Greenwich, the reverse of the convention used by the Classic LX200!

To power off the scope and keep most of the previously adjusted settings, select *utilities, park scope* (perhaps not the obvious menu item to select); this simple act will cause the scope to drive to a known *park* position and (in the case of the LX400) will save the last *focus preset* and other data for availability at power on. If you had changed the focus before *parking* (this is quite likely) then problems can occur with reset data. You can read a full description of the *park* process in the manual and can subsequently *define* your own *park* position. Try using the standard due south on the celestial equator *park* position.

Once your scope is fully operational and has been correctly aligned and synchronized, you should find it very easy to locate several of the planets and even bright stars during the daytime – visually. Consider doing this when Mercury, Venus, Mars, or Jupiter are favorably placed. However, there are caveats that go with such special observations, so this type of viewing cannot be recommended at this stage; wait until you have set up your scope properly.

First Visual Observing Sessions: Finder Adjustment, Focusing, Collimation

It is clearly important to be able to focus your telescope easily. Follow the manual's recommended sequence of operations for your first telescope session, including backlash adjustment. This provides an opportunity to identify a specific landmark for your reference point. A preliminary focusing of the telescope can then be done at this stage while locating your landmark feature. After the backlash measurements and adjustments are completed, you can use the same marker to align the finder – see Fig. 2.7 – precisely. Aligning the viewfinder in the daytime during the first power on session is an excellent strategy.

Although this can also be done at night, the first daytime operation should allow many settings to be achieved before the first evening or night time observing session.

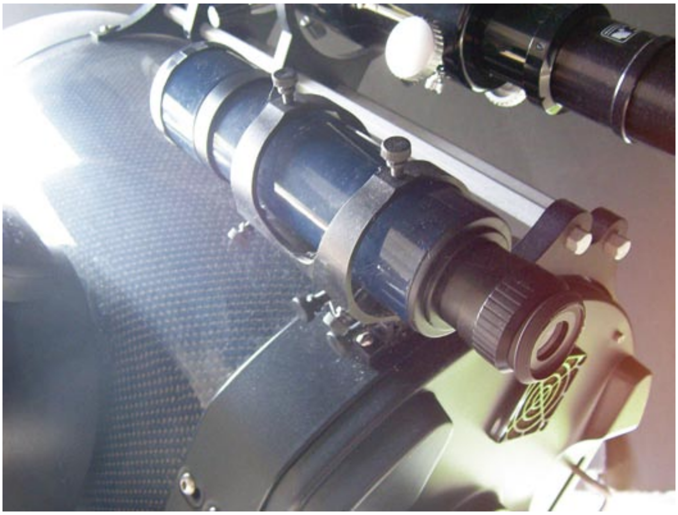

Fig. 2.7 Meade LX200GPS/LX400 Finder mounted on an LX400. The guide scope can be seen above it. It is important to align the finder on a bright target object visible in the main scope. This allows easy guidescope use

Terrestrial focusing will not be precise because the stars are at infinity, but it will be sufficient to enable a later precise focusing when you locate your first star field during the evening. The manual explains how to adjust the finder; four of the six alignment screws can be seen in Fig. 2.7. With the main scope focused and centered (preferably using a reticle eyepiece) on a bright, easily identified star, the finder can be adjusted using these screws until it is centered on the same bright star.

Focusing

The LX200 Classic came with a manual focuser that had idiosyncrasies of its own, as mentioned before. The design of the telescope includes a focuser that manually moves the mirror within a carrier tube backward and forward. This carrier tube is concentric with the telescope's baffle tube (a tube carefully sized and positioned to minimize the possibility of extraneous off-axis light reaching the mirror). The mirror carrier slides along it and experiences some rocking due to mechanical looseness within the system. Focuser adjustments often cause the image to slide across the field of view during the focus process. After considerable practice and manual adjustment, this effect can be minimized by fully winding the manual focus in both directions a couple of times every few weeks in order to better redistribute the grease.

More recent models in the LX200GPS series have a mirror lock and zero image shift microfocusers ushering in a new era of easier operation. As explained in the manual, a first rough (approximate) focus is obtained using the focus knob at the base of the Optical Tube Assembly (OTA). Remember the earlier hint to have the final twist push the mirror to help minimize focuser backlash. The mirror lock, positioned above the coarse focuser, is then rotated towards *lock* to a firm feel to lock the mirror in place. This should eliminate any later mirror flop, a problem observed on some occasions with earlier models when the image crossed the meridian. The microfocuser is used to obtain fine focusing with the advantage of no associated lateral image shift. Before making any further adjustments to the main focuser, it is important to release the mirror lock.

The LX400 model includes a feature incorporating electronic focusing with memory. To illustrate, you can focus the telescope with your current optical setup – whether for visual use with a specific eyepiece or imaging use with a specific focal reducer. This position can be stored as a labeled focus position (the display shows its position in millimeters) and subsequently recalled. You can therefore have settings for the basic f8 optical train using the included 24-mm eyepiece and another for your f6 CCD camera focus point. After swapping the optics, the desired focus position can be called up, activated, and the motors will drive to the recorded position. This is an excellent feature that can be used for changing focus from a night time imaging session to a daytime visual planetary viewing! Several potential storage positions are available, therefore offering multiple-stored optical configurations. Although the separate focus motors installed within the tube add greatly to the weight of the scope, they are extremely useful!

Experience shows that the firmware does require a little focus reminder before the end of a session. This can be performed as follows: prior to the *park* command, in order to properly retain the LX400 focus points, select a *focus preset* (your current application), then the command *park*. There is evidence that *AutoStar II* does not otherwise properly store the focus position, requiring you to manually resynchronize the focus to one of the known positions. It appears that *AutoStar II* only retains which *preset* you are at (one through nine) between sessions, and the *mm-from-zero* that each *preset* represents. At the next power up, it does not apparently remember where it was relative to zero, but if it knows it is at *preset #5* then it can work out where the other presets are.

Hartmann or Bahtinov Mask

A Hartmann Mask is very useful for helping to easily achieve accurate focus. The mask is essentially a cover for the end of the telescope tube and has three (sometimes two) large holes symmetrically placed. This effectively creates three smaller telescopes and therefore three separate images. The mask is placed in position for focusing, at which time the three out-of-focus images should become visible (see Chap. 5, Fig. 5.4), forming a triangle – assuming that focus is somewhere near. For easiest focus, a bright star should be near the center of your image. As you adjust the rough focus, the three images will converge. Using the electronic microfocuser, a near perfect focus should be obtainable. Do remember to remove the mask before continuing!

Some posts to the LX200GPS forums have referred to the Bahtinov mask (see Chap. 3, Fig. 3.10) for assistance with focusing. This mask covers the front of the OTA and has a series of slots cut into its material, producing a complex pattern. For perfect focus the central line in the star pattern should be exactly between the two diagonal lines. See the "Accessories" section of this book for more details.

Changing Speed

Right at the start of the tests with your new scope, it is strongly recommended that you set the scope's maximum *goto* speed to about 1.5° (many use 3°) per second. The scope's default speed is at maximum, so any use of the *goto* option sets your scope driving at top speed. Nothing – apart from a badly balanced scope – is more likely to quickly wear out your gears! Setting a new maximum speed is just one parameter that you can investigate during the first few sessions; during this time you can gain familiarity with the handbox controls. It might be useful to print out a copy of the entire command listing as provided in the manual. This list is retained in the observatory. Be aware that some recent modifications to the menu structure are not reflected in the manual.

LX400 (and LX200GPS with Care) Handbox Removal

Another useful option that may not come to light for a while is the removal of the LX400's handbox during a session. The LX400 handbox can be removed once the scope is powered up and can be (hot) reconnected later for power down. This is mostly of use during computer-driven (remote) operations when you are sitting in the house and controlling the telescope during a home network session. This is many people's normal operational mode. During very cold sessions the handbox is best removed from the scope and kept indoors (or at least protected in an insulated bag) in relative warmth. Many users feel that the inherent design of the handbox does not optimize its operation in very cold conditions. Often keys will not operate correctly, or the display will become distorted in such weather. When the liquid crystal display (LCD) cools down, the motion of the suspended crystals will slow in response to the changing electric fields. The formation of dew on the switch contact pads inside the handbox effectively short-circuits (simulating presses on) many of the keys at once. The handbox can therefore be confused by the false signals and probably will ignore genuine ones. Having a suitable cover for the handbox under such conditions is an important thing.

The handbox can be reconnected at the end of the session when you are ready to park the instrument. Note that you may need to hold the ? key to achieve a resynchronization of the *AutoStar II*. The LX200GPS handbox is reportedly also hot pluggable, followed by the key press to update the display. Many software applications, including Meade's *AutoStar Suite,* will control the telescope without the presence of the handbox, including parking.

Collimation

Your Meade LX series scope is a precision, advanced optical system and, as such, it deserves a precise alignment of its optics. The process of ensuring centralization of the mirror with the secondary in relation to the field of view is known as collimation. When the scope leaves the manufacturer the optics are accurately collimated; journeying across the continent(s) is likely to have some effect – however minor – on this alignment. The LX200GPS and LX400 series scopes have features that allow for the precise alignment of these optics, and the manuals give full instructions on performing this process. The LX200GPS has three adjustment screws set in the front end of the telescope. The LX400 has built-in focus motors that can be controlled electronically for adjustment by the handbox. In each case, the relevant manual describes the process, and both processes – as described here – can be done within perhaps an hour. Use a high elevation bright star (thereby minimizing the effects of atmospheric turbulence), making the adjustments after defocusing (see Fig. 2.8 and next section). Collimation procedures are best performed after any significant optical change, such as after changing from

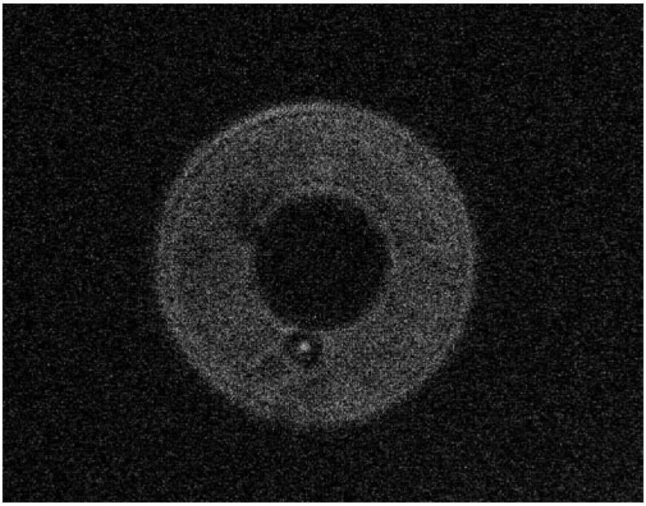

Fig. 2.8 An out-of-focus image of a star used during manual collimation of the scope

f10 to f6.3 or whatever comparable changes you decide to make for specific imaging projects. Such readjustments may be minimal.

To proceed with collimation, insure that the scope is temperature stable and then, as mentioned previously, select a fairly bright, high elevation star. The process involves defocusing the star, as shown in Fig. 2.8, and carefully examining the image. The central dark area is actually the shadow of the secondary mirror; it may or may not be centered in relation to the unfocused star. If it is off center, the optics require collimation adjustment. By carefully placing one finger on one of the three set screws on the black plastic secondary mirror support, you can identify which screw needs to be adjusted as follows: slowly move your finger until it is seen to be over the thinnest part of the concentric circles. Your finger will be either over one screw or between two screws, pointing at the third. The process of adjustment will cause the defocused star to cross the field of view, so to prepare for this, move the field at the slowest drive rate in the same direction as the darkest offset. The identified screw is then turned with extreme caution and by only a very small amount. By repeatedly checking the result of this adjustment, you should be able to obtain concentricity. The accuracy of this process depends on your judgment; however, in a later chapter on advanced software, we will explain about the use of software that can help quantify the collimation and achieve a surprisingly good result.

The manual provides a useful description of the process. After completing a basic collimation using the 26-mm (supplied) eyepiece, if you wish to further optimize the collimation you can use a 6-mm orthoscopic eyepiece for precise, sensitive adjustment. Accurate collimation results in the best quality views by enabling the best possible focus obtainable from your instrument. In turn, this results in the scope delivering the deepest views possible under the current circumstances. Collimation should normally take no more than about 20 min or so when done this way (manually) or possibly even less using the LX400 with its electronic collimation feature. It should only need to be done following optical configuration changes.

LX400 Collimation

Uniquely, the LX400 is collimated electronically using the handbox in collimation mode. The instructions are similar; only the method has changed. Key presses substitute for delicate screw turns. Additionally, there is a factory default setting available, so if you wish to retrieve the original factory-defined collimation, you can activate this option. When activated, the focus motors run at maximum speed until they reach the end of their travel; then they run back at maximum speed until getting close to the right encoder reading. They slow down until they are in the default collimation. Hearing your focus motors run at high speed is an unnerving experience; be prepared.

When you have achieved your best collimation setting you can save it (only in the LX400 scope) using the *collimation, save as default* option. On startup you could then do a *set to factory collimation*, thereby ensuring that the focus encoders record exactly where the corrector is. It is useful to realize that if your LX400 focus motors inadvertently enter runaway mode – a highly undesirable state – as well as hitting the mode button as quickly as possible to try to terminate this, you can subsequently activate the factory collimation default if your motors hit the stops. Focus motor runaway can occur on occasions when it is not expected – such as when using a focus preset – so always be prepared to hit the mode button; this will normally terminate the current action.

AutoStar Suite Operations

There is much useful software available for the LX200GPS series scopes, and it can be downloaded from Meade's Web site (see below). The *AutoStar Suite* comprises a set of features, all of which can be accessed within the program: a sky map (planetarium section), telescope control, the *AutoStar* image capture and processing facility, and the *AutoStar Update* option (see Fig. 2.9). The latter option can also be started independently if required. During your early sessions with the scope it is recommended that you familiarize yourself with some aspects of this software, particularly the planetarium part and mount control (see next section).

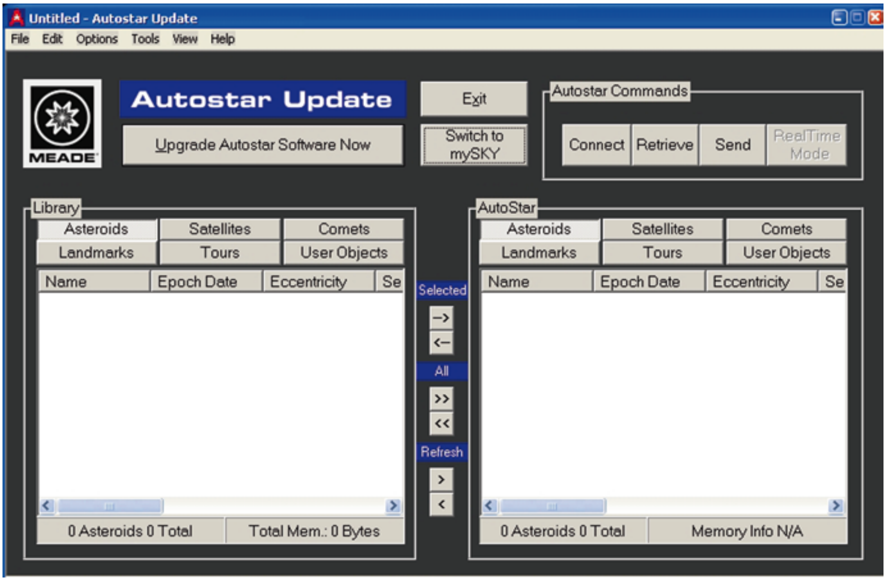

Fig. 2.9 The *AutoStar Update* program. Used for loading tours and firmware updates, etc. into *AutoStar II*

The similar-sounding *AutoStar II* software controls the telescope via the handbox. At a later stage, you may want to look at the mount modeling mode that Meade calls Smart Mount Technology (SMT) – a powerful option within the *AutoStar II* software. This is activated via the handbox, in which you select and identify a number of bright stars and center them in the field of view. The scope's software records these positional results and produces a mathematical model of the sky in relation to the mount's recorded position. When the model is complete and activated, pointing accuracy – as used by the *goto* facility – should be improved. The word "should" is significant here! As will be seen in a later chapter, bugs in the SMT can badly affect localized pointing. Although the scope's own printed manual does not include much material about the *AutoStar Suite* itself, it does briefly explain its operation. The LX400 is provided with a CD that includes these programs, along with other software and detailed descriptions.

The *AutoStar Suite* includes a help section that describes most if not all options. However, it is not difficult to master the application of the program. It is recommended that you use the *AutoStar Suite* and its planetarium component to confirm that your scope will connect to the computer using the supplied cable (where appropriate), and that it can be driven around the sky via the planetarium component. Should there be any queries about telescope control, use this software to check that the entire system is working normally. If you cannot control your scope using the *AutoStarSuite*, you are unlikely to be able to use it with a third-party program.

One word of caution: at this early stage, do not drive your telescope around without actually being there – for example, using a remote control facility or via a network. The scope has no way of knowing whether a cable is catching on something, getting taut, or whether something unexpected is in the way.

AutoStar Suite Updates

From time to time Meade has issued updates to the LX200GPS and LX400 series firmware and software. All such upgrades can be downloaded from the Meade site and then installed using the *AutoStar Update* software. Later versions of the LX200GPS telescope utilize improved firmware by using flash memory. Although these updates can be spotted if you have a regular look at Meade's Web site, it is far easier to continue to monitor the relevant forums where announcements are made about upgraded software. However, you should master the use of whichever firmware version comes with your telescope, rather than immediately try to upgrade it when a new version is released. Updating the *AutoStar* or *AutoStar II* is not a task to be performed without familiarization. We look at this upgrade process later in this chapter.

Meade's download site: http://www.meade.com/support/downloads.html

Connection to AutoStar Suite

Assuming that you have already installed the *AutoStar Suite* and followed the advice in the manual to install the telescope drivers, connection from the telescope to the computer running the *AutoStar* program should be straightforward. The LX200GPS series telescopes use a serial connection (see Fig. 2.4) for commanding telescope movements; the LX400 series can use either a USB connection (using the telescope's USB port) or a serial connection. Operations are therefore slightly different for each connection sequence. A useful tip to follow is that whenever you are connecting any cable between the computer and telescope you should call up the *operating system's device manager.* This instantly displays the actual com port used by the scope. This information may be required when configuring software for telescope control. Note that these details do not apply to Mac OS X users.

Your computer – particularly a modern laptop – is unlikely to have a serial port, so a USB-to-serial adapter may be essential. Use one to control your *Adaptive Optics* unit (see Chap. 9); you may need one for telescope control. Success has been reported using the Keyspan USA-19HS USB-to-serial adapter, and the associated device driver retains its COM port number when moved to different USB ports.

Depending on which scope you have, connect the supplied cable to your computer's port and the other end to the special connector on the telescope's main panel. With the *AutoStar* planetarium suite running, select *telescope, protocol* where you can ensure that the *none* option (if using USB) is ticked – or other number

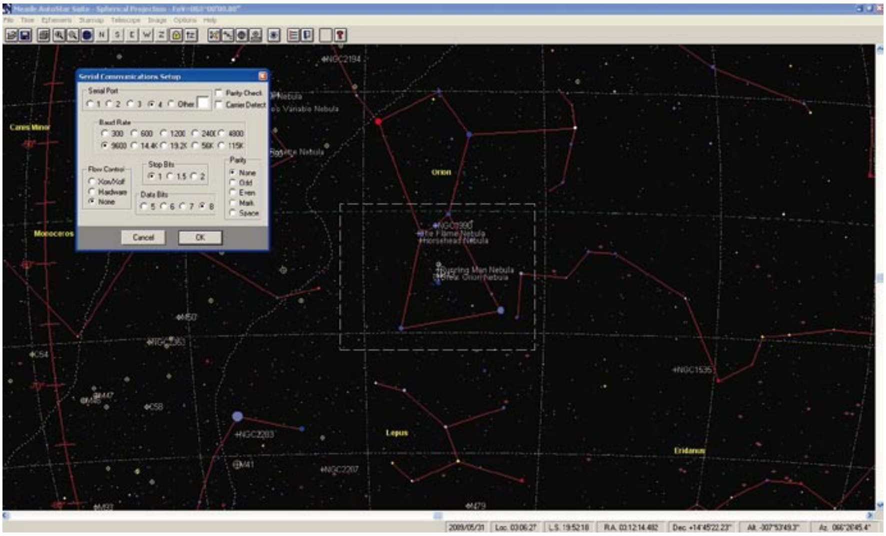

Fig. 2.10 *AutoStar*-COM port selection. Ensure that the correct COM port number is entered

as shown on the device manager display. Control can also be performed using a modem or network. The telescope end of the cable will see a com port because there is a built-in USB to serial adapter within the LX400 panel. If you now call up *device manager* (found on the computer's control panel option) you should see the active com port listed as *Prolific*. This will be the port number that you select for communications. The *AutoStar Suite* software offers radio buttons for COM ports 1–4, but you can enter a different number after you identify the correct COM port. Before you plug in the USB connectors into the computer, always activate *device manager* to see which com ports have been selected by Windows. Usually it is the same numbers – but not always!

Select *telescope, communications, com port setup* – see Fig. 2.10 – and select your *transfer speed*. If you are upgrading the handbox firmware, you can select a much higher speed for the transfer process. With the transfer speed at 9,600 baud, the update can take over an hour! Advice on the LX400 forum was to change the speed to 56 k baud. The upgrade should take only minutes. For routine telescope control it is essential to ensure that the speed is set to 9,600 baud in order to ensure that control commands are correctly interpreted.

Telescope Control

With all settings correct and the cable connected, you should be able to use the *AutoStar* program to control the telescope, as described in the online (pdf) manual. Targets can be selected and the telescope commanded to move to them. Similarly, the star map can be told to move to the telescope's reported coordinates. This process can be tested during the day to ensure that the telescope moves under control. If there are any obvious problems, they can be fixed during the day, rather than spending precious night time hours faultfinding under conditions of semidarkness.

Menu Tree

Use with caution! With Meade's *AutoStar Suite* connected you can start the remote handbox (*Telescope/Protocol/Remote Handbox*); you will see that it forms a complete tree view (with [+] to expand the branches) of your entire menu in the left frame of that application. You can now see where all the options are, one or two of which may not be as indicated in the manual. Do be careful before using some of the less frequently used options; some entries may not be valid all the time. One user cites the case of the *Ambient Temperature*, a display available on the handbox that only appears in the menu system after 10 min have elapsed from the time of the GPS Fix. This allows the thermal sensing hardware to stabilize and to ignore the nearby warm GPS receiver. Although always accessible from the remote handbox tree it will simply report the wrong value.

When your first night time session arrives, using visual mode (with the supplied eyepiece) you have the opportunity to master several features, including the focuser. If focus was last done using the terrestrial target during backlash adjustment, it should already be close to precise focus. Drive the scope to a bright star and center it in the finder's field of view that was previously aligned during the day. The LX200GPS has the mirror lock knob (previously discussed) that can be moderately tightened to minimize the mirror's tendency to move during some telescope movements. Before adjusting the coarse focus this lock should be released. Adjust it for best rough focus. The microfocuser can be adjusted to one of four speeds and then used to provide fine focus. This position can be stored on the LX400; note that the LX400 has five focus speeds. The correct procedure for storing positions is as follows: use *define*, and after confirming the label, hold the *enter* key for a couple of seconds to produce the beep. With the bright star centered in the eyepiece view, make any adjustments needed to ensure that the finder is also centered. This will ensure that when any required target is centered in the viewfinder scope, it will be well within the field of view of the main scope.

When using a CCD camera and the associated software as described later in this book, you can monitor the real-time analysis of a star's image to obtain best focus. This removes the need to scrutinize the visual appearance of the star through an eyepiece – a tiring experience. An electronic focuser was one of the early accessories of the LX200 Classic.

Note that the *AutoStar* software does not seem to fully control the LX400. Some tests indicate that you can make only one move of the focuser either in or out; proper focusing appears to be impossible.

Updating ASU and Firmware

As referred to earlier, updating the software/firmware should not be undertaken until you are experienced at using the telescope and software; there are pitfalls for the novice user, so be aware. A further word of caution: run your computer from the mains – not its battery! Should your battery fail during the update, you will probably need to do an emergency reload (see later notes on *Restoring a Corrupted Handbox*).

When you are finally ready, download the latest *AutoStar Update* (*ASU*) application from Meade's Web site (assuming that you do not already have it installed). The *ASU* software features a connection between the computer and the telescope, providing a communications link via the cable through which firmware updates can be sent. The program offers access to the handbox contents such as asteroids, landmarks, and tours. These can be retrieved as well as modified, making it a fine program for producing tours of the sky for star parties, as well as for the serious use of updating the firmware.

Download the latest firmware version for installation in the scope's computer – if not already done. The firmware provides calculations for pointing as well as other features. Install the *ASU* application on your computer. The downloaded *ASU* file can be run and the instructions on the screen then followed; accept the default settings. The firmware can be unzipped and the final ROM file placed in the *Ephemerides* folder under the *ASU* application folder. All the instructions are provided.

The sequence can be summarized as follows:

1. The telescope and computer can be powered up. If you have a screensaver running, disable this to insure that there are no sudden breaks in operation.
2. Connect the standard LX200GPS/LX400 interface cable between your computer's serial port and the leftmost RS232 port on the telescope's control panel (next to the HBX port).
3. Run the *ASU* program. Check that the proper COM port has been selected.
4. Select *Connect*; then set the maximum baud rate to 57,600.

SMT recordings (see later explanation), PEC data, and all saved user objects should survive a firmware update. It is, however, likely that you could lose *Site*(s) data, *Training* and *Calibrate Sensors* results (applicable if your scope is alt-azimuth mounted). If you have data that you wish to save, you can retrieve and save it as follows:

Retrieve hand controller data by pressing *Retrieve* under *AutoStar* Commands. Save the data via *File/Save Hbx Data.*

Although an upgrade itself should not corrupt PEC data, this data may be corrupted by the *AutoStar Save Hbx Data* feature, so this should be excluded from the save process.

Upgrading Firmware

Continuing with the upgrade process: Select *Upgrade AutoStar Software Now.*

In the dialog box select *Local* and insure that the latest version of the firmware previously placed in the *Ephemerides* folder (as described above) shows under *Select* from versions on the hard drive.

Leave *Erase User Banks* unchecked. Click *OK*.

Respond *OK* when the prompt displays.

Respond *OK* when the *Clear User Data* box opens.

The message confirms all is well, so press *OK*.

The lower left corner of the *ASU* application now displays the progress of the update. The hand controller display shows: *Downloading. Do not turn off.*

If you previously set the baud rate to the 56 k setting, the process should be over within perhaps 10 min. Monitor progress occasionally during this time. When the update is complete, the hand controller will automatically restart and then prompt you for location and telescope information. Follow the prompts as normal. Your custom data should still be installed. If custom data is absent, you can reinstall your saved data to your telescope by the following process:

From the main menu, select *File/Open*; locate your previously saved data and *open* the file. Drag the file(s) to the *Handbox View* and press *Send*. When complete, power cycle the telescope (turn it off, wait a few seconds, and then turn it on). Check the various menus to see whether any of your data has changed or remains correct. When you have established that everything appears normal, you can then proceed to configure the settings – such as *GPS alignment* – as required. It would be reasonable to recalibrate the sensors and retrain the drives after any firmware update.

Use the Latest Firmware

Installing the latest firmware for your telescope – whether LX200GPS or LX400 – is highly recommended, once you are fully familiarized with the currently loaded version. It should ensure that, at least in most cases, bugs that were identified and reported to Meade (and hopefully fixed!) are finally laid to rest in the update. Never was this more evident than when a number of early updates to the LX400 firmware finally corrected the errant PEC data retention. However, PLEASE remember that you should familiarize yourself with the supplied firmware and *AutoStar* operations for some observing sessions before you tackle the advanced procedure of updating the telescope firmware.

Restoring a Corrupted Handbox

It can happen that during a software upgrade to your handbox, the flash memory used to store programs could get corrupted, leading to a nonfunctioning telescope, or the handbox display may disappear or show garbage characters. This is most likely to occur if the upgrade process is interrupted before completion.

A fresh firmware reload can be initiated as follows: insure that all power to the scope (and handbox) is off. The handbox should be connected to the telescope and the computer with the telescope power off. Power the telescope on and immediately press the 9 button three times (999) on your *AutoStar II* handbox. The message "*Downloading... DO NOT POWER OFF*" should appear. If so, all should be well! Leave the process of reloading alone until it finishes.

Be aware that a new version could bring its own new bugs. You should perhaps wait a few days after a new release in order to find out what the program experts have found when testing the new version.

Free User Software

Andrew Johansen's *PEC editor* and *AutoStar information* pages form an invaluable aid to save (and even edit) the user data in your scope's memory. His application saves *all* user data and does not touch the code. Meade's *ASU* does not save all user data (such as SMT). Andrew Johansen's Web site is http://members.optusnet.com.au/johansea/.

Michael Weasner's Web site is a mine of information about all versions of the *AutoStar* – well worth visiting: http://www.weasner.com/etx/AutoStar_info.html

There is also a commercial updater program *StarPatch* available from *StarGPS*: http://www.stargps.ca/starpatch.htm

This program is more robust than Meade's updater when you have to deal with poor PC-to-telescope connections and even USB drivers, and it also applies patch kits. One user reports that it does not touch stored user data, such as PEC. The software is supposedly free for updating purposes and could be helpful for those experiencing problems with Meade's program.

Telescope Alignment

You will probably have discovered from the beginning, as well as having read the manual, that *Autostar II* asks you to perform a star alignment during the post power on initialization stage. There is a choice of one- or two-star alignment options. When the telescope has been in normal operation with the GPS receiver providing time and location data (resulting in *Autostar II* knowing where it is pointing), the recommended option is the one-star alignment. There are two situations here to be aware of.

Bugs have been identified in the *Autostar II* firmware associated with the simple two-star alignment. Under certain circumstances, this process leaves corrupted data in the *Autostar* software that affects future operations until cleaned up. You can clean up this corruption as suggested by Richard Seymour as follows:

1. Change the telescope setting to *alt/azimuth* aligned.
2. Perform a *one-star* alignment in that mode.
3. Press *enter* when it asks to center the stars.

That process will clean up the corruption. Then set the *Autostar II* back to *Polar*.

Goto Synchronization

During every observing session there will most probably be a nominal error between the position moved to by the telescope after a *goto* command has been issued on the handbox and the precise target coordinates stored within the telescope's database. It is possible to improve future accuracy as a first stage by synchronizing the telescope's encoders to the real target position. After a *goto* has been executed for slewing to a bright star such as Aldebaran, if the target star is off center, center the star in the eyepiece using the *N-S-E-W* keys; press and hold *enter* for about 3 s. The display shows that the handbox is ready to accept the position correction, so press *enter* again; a beep of recognition follows. Later *goto* selections in the same region of the sky should show improved accuracy. Be aware that *goto* errors will accumulate in other regions of the sky. Ideally you should use an illuminated reticle eyepiece for this. There is also a *High Precision Slew* option that takes you to the nearest bright star prior to your selected target, enabling you to center it exactly and therefore improve local target location. This can be useful for identifying some deep space targets. For the next level of accuracy, the scope offers a *Smart Drive* and a *Smart Mount* facility.

Training the Drive

All telescope mounts suffer from some degree of backlash. This is a mechanical defect resulting from an imperfect drive train. Slews in one direction followed by a slew in the opposite direction are not perfectly consistent. For example, if you *goto* an object – such as a well-known bright star on the other side of the sky – and then *goto* the previous bright star, the scope is unlikely to arrive at exactly the same place. Mechanical backlash usually leaves a residual difference along both the RA and declination axes. However, all good mounts provide the means to minimize this discrepancy, and the LX series offers its version – *drive training*. The manual offers a description of the process in the appendix. We recommend using the scope in visual alt-az (altitude-azimuth) mode for this daytime operation, regardless of whether the scope is on an equatorial wedge or not.

Using the handbox, select (from the main menu) *setup, telescope, train drive, az* (azimuth – horizontal) *train.* The handbox instructions then guide you through the process of selecting a terrestrial target and centering it. After completing the azimuth training, repeat the process for the alt(itude) setting. Positions are recorded for drive movements in both azimuth directions and both elevation directions. The differences are noted internally, and the mount subsequently compensates for this. This should minimize the extent of backlash during subsequent slews and should therefore improve pointing accuracy.

The use of a terrestrial target is obviously beneficial! Such targets do not move during the measurements, eliminating any other errors that could confuse the measurements. Meade recommends repeating this drive train process every 3–6 months. It may also be worth repeating the process following any *AutoStar* update in order to avoid the risk of the telescope drive overshooting.

Smart Mount

This is an advanced feature that offers improved pointing accuracy. It requires the user to make a series of specific star position measurements, over a period of between 1 and 2 hours. The process involves activating *Smart Mount* and then centering, in turn, a sequence of some 45 or more handbox-selected stars. Although you can visually center these stars in an illuminated reticle eyepiece, the process can also be carried out using a CCD camera. This process could therefore be carried out later, once a camera is connected via a computer.

Meanwhile, you can still use the visual method to advantage. The manual explains the process. After enabling *Smart Mount*, configure the *AutoStar Suite* planetarium program and set it to follow your mount's position. This way you can see the field anticipated by the telescope and insure that it is matched to the image, thereby avoiding wrongly identified stars. After the scope slews to the first star, you center it, and then press *enter* as instructed. The *AutoStar II* software records any position discrepancy. There is provision for a particular star not being visible due to a physical obstruction: press the *Mode* button, and the handbox selects the next star. Several stars might have to be bypassed during this session if there are environmental obstructions.

There are two points of which you should be aware during this process. The telescope initially selects several bright, well-known stars, but they are usually separated by large distances; this results in your telescope crossing the sky through large movements. Andrew Johansen (mentioned earlier) analyzed the code for this process and explained that the sequence is examining stars within grids that are derived from an algorithm; the actual grid varies with the mount's mode (polar or alt-azimuth), completing two loops – one for azimuth and one for altitude – resulting in the movements seen.

Hopefully all should be well with your SMT project, but you may find that after doing several stars successfully, it drives to the next star but misses it by a large margin. All you can do in this instance is to *mode* to the next star. Should this problem occur repeatedly, there appears to be little that we can do to correct it. study the help file in Andrew's *Beta PEC editor* to learn what could be going on. The editor also displays your SMT model in a grid format, so you can see your end result.

The process usually takes an hour or more to complete, after which the modeled scope can then be saved and subsequently left activated or deactivated. More than one model can be produced, according to your current optical configuration. If you commonly change between two configurations using different balance conditions, you can save the results from these two SMT runs and load the appropriate one when required. *Smart Mount* activation may then improve the telescope's pointing accuracy for you.

Testing SMT

After the process is complete, test the mount using selected stars on the handbox. Hopefully you should at least see something of an improvement in pointing accuracy. Also available within the *Smart Mount* facility is the update procedure. On selection you have to center a selected star; following this, any future sync operation will modify the stored *Smart Mount* database. Again, Andrew's analysis of this process suggests that only stars brighter than magnitude 4.0 will cause the SMT model to be updated. Fainter stars, when synched, will merely adjust the scope's encoder offsets.

Caution, Static!

It is recommended that when not in use, all cables to the front panel should be disconnected. This is to minimize the chance of static electricity damaging the telescope electronics.

Daytime Planetary Viewing

One huge advantage of the LX200 Classic was its ability to be easily synchronized with the sky and the consequent ease of finding the brighter planets during the day. The principle here is that the telescope is always started from a standard parking position. It should be noted that alt-azimuth and equatorially mounted telescopes have different default park positions. The former points due north and at zero altitude in the northern hemisphere, but the wedge-mounted scope points due south and zero declination. Southern hemisphere telescopes point due north when parked.

With the LX200GPS in alt-azimuth mounted mode, in which the base of the scope lies flat on the base of the mount, at power up the scope already *knows* exactly where it is positioned: due north and zero degrees elevation. The motherboard battery (at least in the early models) seemed to insure that it retained the time and the previously entered location coordinates (latitude and longitude). This data is now stored within the flash memory of the *AutoStar II*, and this means that the scope can calculate exactly where it is pointing in the sky. This knowledge results in the handbox *RA-dec* display updating from power on, but only if the GPS setting is *GPS at startup*; otherwise, the time remains unknown. For precision astronomy, the displayed RA and Dec can be confirmed by using the *goto* feature to target a bright star – but never the Sun! One serious point here: as already mentioned, under no circumstances must the telescope be allowed to slew across the disc of the Sun. Such an incident could have the most appalling consequences. Before any daytime *goto* is executed, the front cover of the telescope and the covers on any mounted telescopes – such as the finder – must be securely fitted.

If the planet Venus or Jupiter is visible and sufficiently far from the Sun during the day, the *goto* facility can be used – after taking suitable precautions, as described above and in the manual – and the planet should be seen somewhere in the resulting field of view. This requires only that the telescope should have been powered down via a park command on the previous occasion and is already focused for the eyepiece. You are likely to find it very difficult to focus during the day unless the planet is already near the correct focus position. If a bright moon is visible in the daytime sky, focusing on that is relatively easy. The *goto* feature should only be used when you are familiar with the process and know how the telescope will move. It could be disastrous if the scope drove uncovered in front of the Sun while on the way to locate a planet!

Yahoo Telescope Groups

Yahoo is home to many groups devoted to telescopes, CCD cameras, and other associated topics. The following list shows a number of telescope forums that may be of interest:

http://tech.groups.yahoo.com/group/RCX400/
http://tech.groups.yahoo.com/group/LX200GPS/
http://tech.groups.yahoo.com/group/ASCOM-Talk/
http://tech.groups.yahoo.com/group/Astrometrica/
http://tech.groups.yahoo.com/group/ccd-newastro/
http://tech.groups.yahoo.com/group/guide-user/
http://tech.groups.yahoo.com/group/heq5a/
http://tech.groups.yahoo.com/group/MaximDL/
http://tech.groups.yahoo.com/group/MPOSoftware/
http://tech.groups.yahoo.com/group/starlightxpress/

Also, see Doc G's Information site about LX200GPS telescopes:

http://www.mapug-astronomy.net/ragreiner/index.html

Commercial Servicing Facilities

It is not the intention of this book to try to include features about repairing or even adjusting the actual mechanisms of your telescope. However, when the need for repair or a desire to have a professional astronomer look and adjust your scope arises, the LX200GPS or LX400 user may wish to look into the service offered by Dr. Clay Sherrod of Arkansas Sky Observatory (see Web site URL). Dr. Clay does the scope optimization himself and his service is recognized worldwide. Review the detailed description of the work included in the service schedule (http://www.arksky.org/supercharge.htm).

Summary

This chapter has described the nature of some of the processes, such as balancing, that must be attended to if you wish to get the very best performance from your high-end Meade telescope. Later chapters describe the processes in detail. If you were not planning to do serious imaging with your scope, some of these processes can be omitted, as mentioned in this chapter. Of course, should you change your mind and decide to take your imaging to a higher level, these additional steps should be well worthwhile. In any case, it is worth reading the chapters so that you appreciate the improvements that are possible to get your scope into top condition.

1. Balancing in both axes is essential for successful imaging; the change from heavy eyepiece to camera options possibly involving reducers and different guide scopes will change the whole balance and therefore physical characteristics and operation of the telescope. Using the scope in an unbalanced condition is likely to lead to rapid wear on the gears. See Chap. 4 for full details.
2. Accurate polar alignment is essential for imaging. Alt-azimuth operation, although adequate for visual observing, is not considered a fully effective option for imaging. Depending on where the telescope is pointing, exposures lasting more than even 30 s or so in alt-azimuth mode can lead to star drift and even field rotation. It is possible to use the *AutoStar Suite* to take multiple short exposure images that the software (and third-party software) can stack. Regardless of the software, subsequent image drift depends on the amount of offset between the scope's polar axis and the true celestial pole. A good polar alignment is not difficult to achieve and opens the possibility of obtaining long-exposure images. See Chap. 3 for full details.
3. A good PEC is very beneficial for imaging. Effective guiding is essential, and this is helped considerably by an efficient PEC. The variations in the mechanical precision of your worm train and gears show up as small changes in the position of the target in your field of view. This has little or no effect in an eyepiece but can cause star trails on CCD images. Chapter 6 explains how to greatly reduce, if not virtually eliminate, these errors.

Fig. 2.11 Jim West's customized LX200 showing an eyepiece tray and Telrad finder

4. Reducing backlash by drive training greatly helps autoguiding. The LX series of scopes have a built-in feature to achieve this. The use of Smart Mount should help *goto* accuracy.
5. Synchronizing your scope's actual position (as shown in the eyepiece or on the screen) with that of its current known (displayed) position should improve future pointing accuracy. This helps speed up readiness for imaging.

Jim West has set up his 8-in. Meade LX200-ACF f/10 telescope as shown in Fig. 2.11. He has fitted a scope Tronix Mount Assist Plate, an Astro Tech 2-in. Dielectric Quartz Mirror Diagonal, and uses the Meade Series 5000 Plossl 26-mm eyepiece supplied with the telescope. Further accessories include the ScopeStuff fine focus knob, the popular Telrad finder, and a Losmandy dovetail plate with Losmandy camera mount.

Your telescope is now mounted and some, though not all of the built-in features, have or can be used to the limit of their initial capabilities. You absolutely must balance the telescope in both axes – so this is the next stage on the road to getting the best from the scope.

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http://www.springer.com/978-1-4419-1774-4

So You Want a Meade LX Telescope!
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Harris, L.
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