CELESTRON®

CELESTRON CG-11 / CG-14
INSTRUCTION MANUAL

The Celestron CG-11

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INTRODUCTION

Welcome to the Celestron world of amateur astronomy! For more than a quarter of a century, Celestron has provided amateur astronomers with the tools needed to explore the universe. The Celestron CG-11 and CG-14 continues in this proud tradition combining large aperture optics with ease of use and portability. With a mirror diameter of 11 inches, your Celestron CG-11 has a light gathering power of 1,593 times that of the unaided human eye, and the CG-14 has a light gathering power of 2,581 times that of the unaided human eye. Yet despite their large apertures, the Celestron CG-11 and CG-14 optical systems are extremely compact and portable because they utilize the Schmidt-Cassegrain design. This means you can take your Celestron CG-11 or CG-14 to the mountains or desert or wherever you observe.

The Celestron CG-11 and CG-14 are made of the highest quality materials to ensure stability and durability. All this adds up to telescopes that give you a lifetime of pleasure with a minimal amount of maintenance. And, your Celestron CG-11 and CG-14 are versatile — they grow as your interest in astronomy grows.

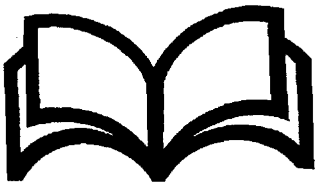
Your Celestron CG-11 and CG-14, however, are not limited to astronomical viewing alone. They can also be used for terrestrial viewing to study the world around you. All you need to do is take the time to familiarize yourself with your Celestron telescope and its operation.

NOTE

The CG-11 and CG-14 share the same mount and are basically the same with the exception of the larger aperture of the 14". So, this manual will basically discuss the CG-11 but will discuss the CG-14 when there are differences.

How to Use This Manual

This manual is designed to instruct you in the proper use of your Celestron CG-11 telescope. The instructions are for assembly, initial use, long term operation, and maintenance. There are seven major sections to the manual. The first section covers the proper procedure for setting up your Celestron CG-11 telescope. This includes setting up the tripod, attaching the telescope to the mount, balancing the telescope, etc.



The second section deals with the basics of telescope use. Topics include focusing, aligning the finder, and taking your first look. The third section deals with the basics of astronomy which includes the celestial coordinate system, the motions of the stars, and polar alignment. The fourth section deals with celestial observing covering visual observations of the planets and deep-sky objects. Using both the setting circles and star hopping are discussed. The fifth section covers celestial photography working from the easiest to the most difficult. The last major section is on telescope maintenance, specifically on cleaning and collimation. **Keeping your CG-11 in proper collimation is the single most important thing you can do to ensure it performs well.**

In addition to the major sections mentioned previously, there is a list of optional accessories for your Celestron CG-11 that include a brief description of its purpose. This is the section to consult when you've mastered the basics and ready for new, more challenging observations. The final part of this manual contains a list of objects that can be observed through your Celestron CG-11 telescope. Included are the coordinates for each object, its brightness, and a code which indicates what type of an object it is. In addition, there is a list of bright stars used for aligning the setting circles.

Read the assembly instructions through completely before you attempt to set up your Celestron CG-11 telescope. Then, once you've set up your Celestron CG-11, read the section on "Telescope Basics" before you take it outside and use it. This will ensure that you are familiar with your telescope before you try to use it under a dark sky. Since it will take a few observing sessions to familiarize yourself with your Celestron CG-11, you should keep this manual handy until you have fully mastered your telescope's operation. After that, save the manual for future reference.

A Word of Caution

Your Celestron CG-11 is designed to give you hours of fun and rewarding observations. There are, however, a few things to consider before using your telescope that will ensure your safety and protect your equipment.

WARNING !

NEVER LOOK DIRECTLY AT THE SUN WITH THE NAKED EYE OR WITH A TELESCOPE. PERMANENT AND IRREVERSIBLE EYE DAMAGE MAY RESULT.

NEVER USE YOUR TELESCOPE TO PROJECT AN IMAGE OF THE SUN ONTO ANY SURFACE. INTERNAL HEAT BUILD-UP CAN DAMAGE THE TELESCOPE AND/OR ANY ACCESSORIES ATTACHED TO IT.

NEVER USE AN EYEPIECE SOLAR FILTER OR A HERSCHEL WEDGE. INTERNAL HEAT BUILD-UP INSIDE THE TELESCOPE CAN CAUSE THESE DEVICES TO CRACK OR BREAK, ALLOWING UNFILTERED SUNLIGHT TO PASS THROUGH TO THE EYE.

NEVER LEAVE THE TELESCOPE UNSUPERVISED, EITHER WHEN CHILDREN ARE PRESENT OR ADULTS WHO MAY NOT BE FAMILIAR WITH THE CORRECT OPERATING PROCEDURES OF YOUR TELESCOPE.

NEVER POINT YOUR TELESCOPE AT THE SUN UNLESS YOU HAVE THE PROPER SOLAR FILTER. WHEN USING YOUR TELESCOPE WITH THE CORRECT SOLAR FILTER, ALWAYS COVER THE FINDER. ALTHOUGH SMALL IN APERTURE, THIS INSTRUMENT HAS ENOUGH LIGHT GATHERING POWER TO CAUSE PERMANENT AND IRREVERSIBLE EYE DAMAGE. IN ADDITION, THE IMAGE PROJECTED BY THE FINDER IS HOT ENOUGH TO BURN SKIN OR CLOTHING.

The Schmidt-Cassegrain Optical System

A telescope is nothing more than an instrument that collects and focuses light. The nature of the optical design determines how the light is focused. Some telescopes, known as refractors, use lenses while others, known as reflectors, use mirrors. The Schmidt-Cassegrain optical (or Schmidt-Cass for short) system uses a combination of mirrors and lenses and is referred to as a compound or catadioptric telescope. This unique design offers large diameter optics while maintaining very short tube lengths, making them extremely portable. This makes them extremely popular among amateur astronomers. The Schmidt-Cassegrain system consists of a zero power corrector plate, a spherical primary mirror, and a secondary mirror. Once light rays enter the optical system, they travel the length of the optical tube three times.

Inside the optical tube you will notice a black tube (not illustrated) that extends out from the center hole in the primary mirror. This is the primary baffle tube which prevents stray light from passing through to the eyepiece or camera without striking the primary or secondary mirrors.

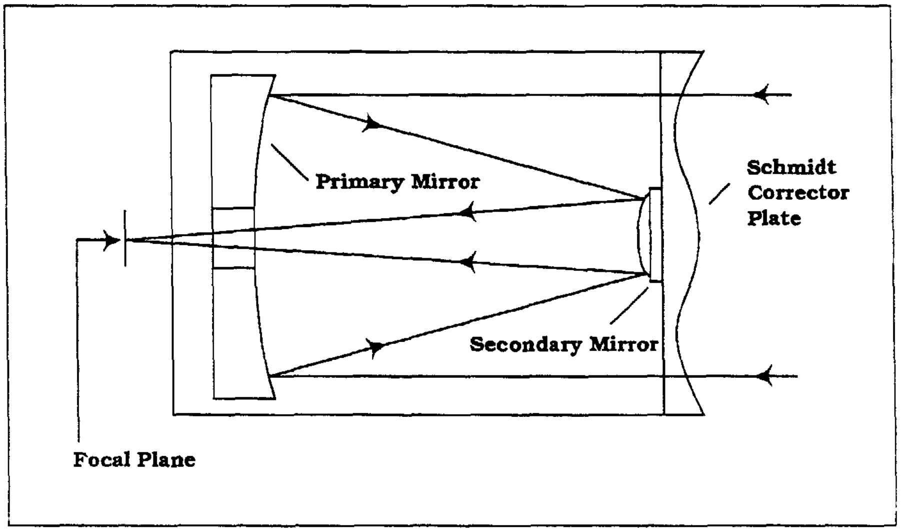


Figure 1-1

This cross-sectional diagram shows the light path of the Schmidt-Cassegrain optical system. Note that the light rays travel the length of the telescope tube three times, making this a compact optical design. Note that the curve of the corrector plate is greatly exaggerated.

ASSEMBLING YOUR CG-11

This section covers the assembly instructions for your Celestron CG-11 telescope. The Celestron CG-11 should be set up indoors the first time so that it is easy to identify the various parts and familiarize yourself with the correct assembly procedure before attempting it outdoors.

The Celestron CG-11 is a standard 11" Schmidt-Cassegrain telescope on a heavy-duty German equatorial mount. The Celestron CG-11 comes standard with Starbright ™ coatings, an enhanced multi-layer aluminum coatings on the primary and secondary mirrors for increased reflectivity. Also, the corrector plate is fully coated to allow maximum light transmission. The Celestron CG-11 is shipped in six boxes. One contains the telescope and is accompanied by a box that contains most of the standard accessories, which are:

- 26mm Plössl Ocular 1-1/4"
- Visual Back 1-1/4" (2" Visual Back on the CG-14)
- Star Diagonal 1-1/4" (2" Mirror Diagonal for the CG-14)
- 7x50mm Straight-Through Polaris Finder with Bracket
- DC Adapter (Cigarette lighter plug)
- Lens Cap

In separate boxes are the following:

- Equatorial Mount
- Central Column (i.e., tripod head) and Electronic Console
- Adjustable Tripod Legs, Counterweight Bar, Leg Clamps
- One 22 Pound Counterweight (Two additional weights for the CG-14)

Included is all the hardware needed to assemble the telescope.

Use the diagram on the following page (see figure 2-1) to familiarize yourself with the various parts of your Celestron CG-11 telescope.

Unpacking Your Celestron CG-11

Remove all the pieces from their respective boxes and place on a flat, clear work area. A large floor space is ideal. When setting up your Celestron CG-11, you must start with the tripod and work up from there. These instructions are laid out in the order each task must be performed.

Please note that the flat metal pads on the base of each tripod leg are NO longer offered on the CG-11 telescope. Instead, there is an open ended tube.

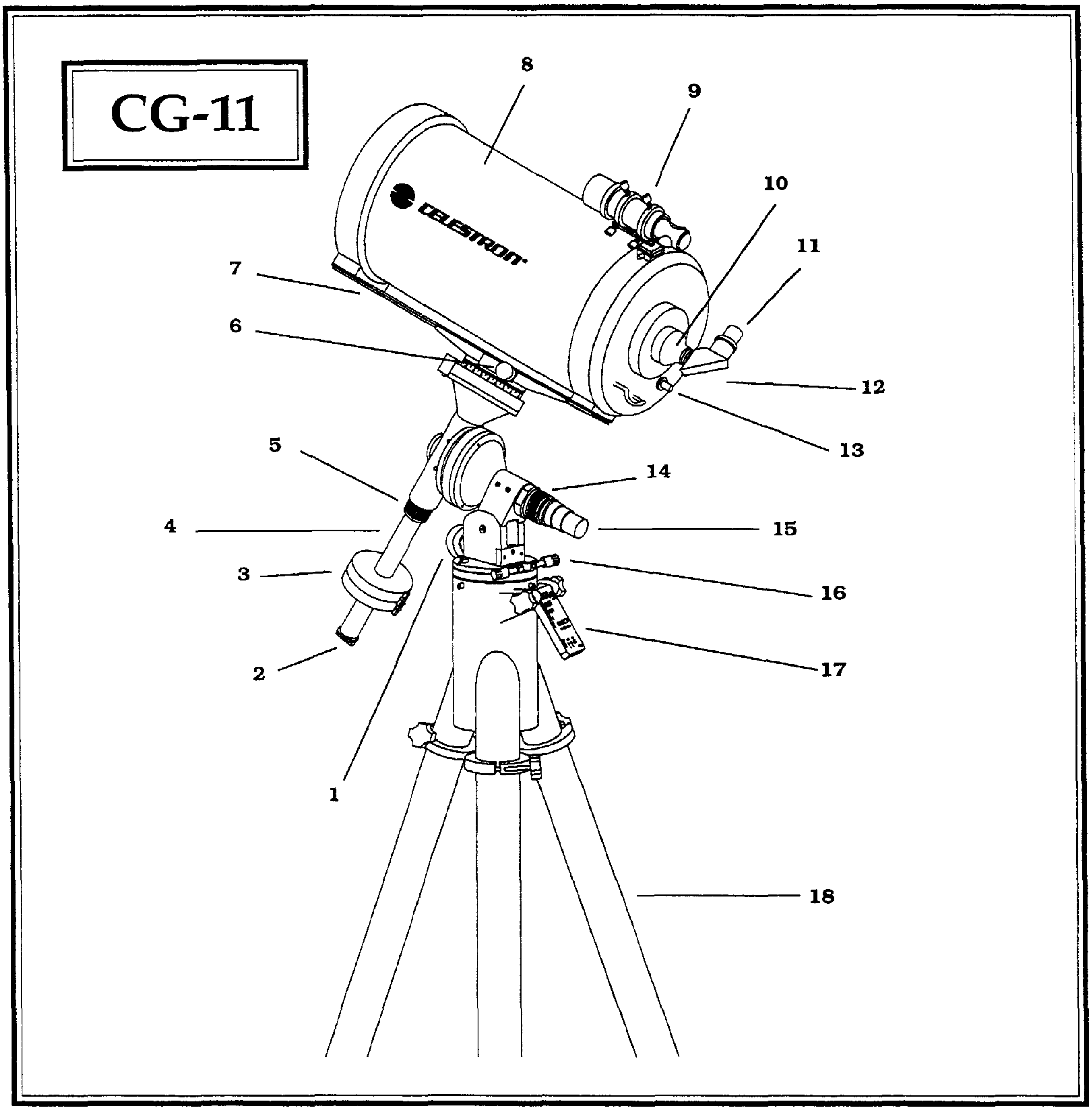


Figure 2-1

1. **Altitude Adjustment Knob**
2. **Safety Thumbscrew**
3. **Counterweight**
4. **Counterweight Bar**
5. **DEC Clutch Knob**
6. **Telescope Securing Knob**
7. **Dovetail Bar**
8. **Optical Tube**
9. **Finder and Bracket**
10. **Visual Back**
11. **Eyepiece (Ocular)**
12. **Star Diagonal**
13. **Focus Knob**
14. **R.A. Clutch Knob**
15. **Polar Axis Finder (Optional)**
16. **Azimuth Adjustment Screws**
17. **Electronic Console**
18. **Tripod Leg**

Setting Up the Tripod

The tripod legs attach to the central column which together form the tripod to which the mount attaches. The Celestron CG-11 comes standard with adjustable legs — 33" to 44". To set up the tripod:

1. Place the central column on the ground so that the leg posts are pointing down.
2. Loosen the 1/4 - 20 set screw on each leg clamp so that it no longer extends into the inner diameter of the clamp.
3. Slide the leg clamps onto the top of each tripod leg (see figure 2-2). Align the 1/4 - 20 screw on the clamp with the hole in the tripod leg.
4. Tighten the 1/4 - 20 set screw on each leg clamp to hold the leg clamp in place.
5. Slide the legs — one at a time — onto the leg posts (see figure 2-3).
6. Tighten the knobs on each leg clamp to hold the legs in place.

The tripod will now stand by itself. Once the tripod sets on the ground, loosen the clamps and rotate the legs until the feet sit flat. Then tighten the clamps.

The central column can be turned upside down to attach all the legs at once and then turned right-side-up after all the legs are securely in place.

HINT:

Since the fully assembled telescope is quite heavy, position the mount so that one of the tripod legs is pointing north before you attach the mount.

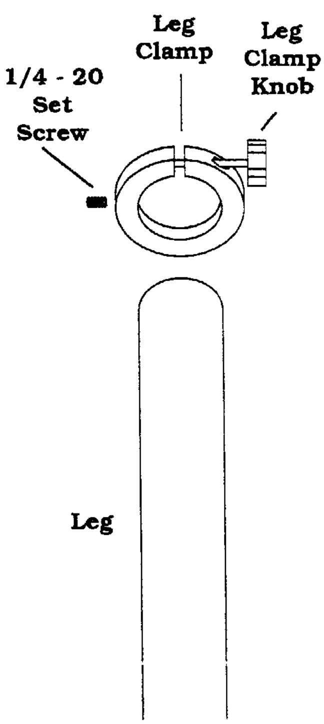


Figure 2-2

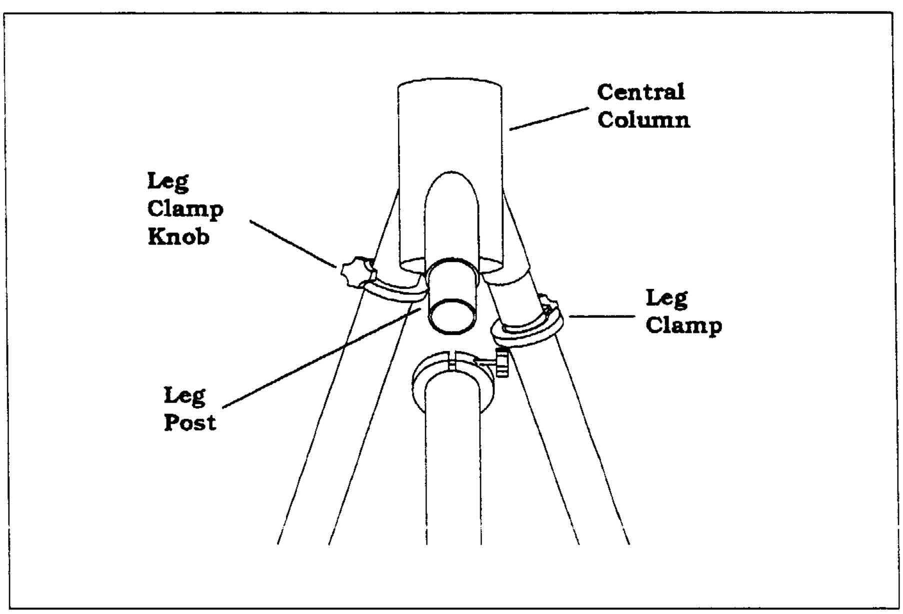


Figure 2-3

Adjusting the Tripod Height

Once the tripod has been assembled, it is a good idea to adjust the length of the tripod legs. It is much easier to do it now before the mount and telescope have been attached rather than afterwards. To adjust the length of the tripod leg:

1. Loosen the knob on the leg clamp so that the tripod leg can be adjusted.

2. Slide the center portion of the tripod leg away from the central column until the leg is at the desired height.

3. Tighten the knobs on each leg clamp to hold the legs in place.

The legs have an adjustable range of 33" to 44". Small adjustments can be made once the telescope has been attached to the mount. It is a good idea to mark the tripod leg to make the process easier in the future.

Please note that the illustrations in this manual do **NOT** show the leg clamps that allow you to adjust the tripod height. The leg clamp does, however, look exactly like the leg clamp that holds the leg to the central column.

Attaching the Equatorial Mount

After the tripod is set up, you are ready to attach the equatorial mount. The equatorial mount is the platform to which the telescope attaches and allows you to move the telescope. The mount is also adjustable so you can orient the axis of rotation so that it is parallel with the Earth's axis of rotation (see the section on "Polar Alignment"). To attach the equatorial mount to the tripod:

1. Insert the base of the equatorial mount into the top of the central column.
2. Rotate the equatorial mount on the central column until the holes in the mount line up with those in the central column (see figure 2-4).
3. Insert the three screws and washers provided through the holes in the central column and into the equatorial mount.
4. Tighten the screws to hold the equatorial mount in place.

There are three possible orientations which allow you to select a convenient location of the electronic console.

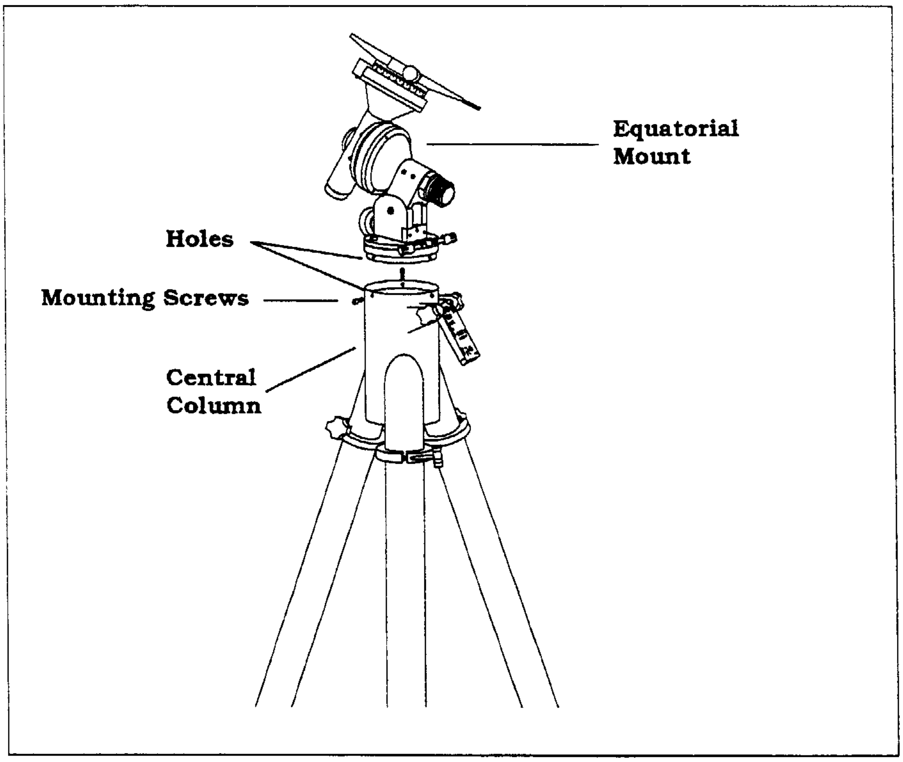


Figure 2-4

Installing the Counterweight Bar

To properly balance the telescope, the mount comes with a counterweight bar and one 22 pound counterweight (the CG-14 has additional weights). To install the counterweight bar:

1. Locate the opening in the equatorial mount on the DEC axis (see figure 2-5). It is opposite the telescope mounting platform.

2. Thread the counterweight bar into the opening until tight.

Once the bar is securely in place you are ready to attach the counterweight.

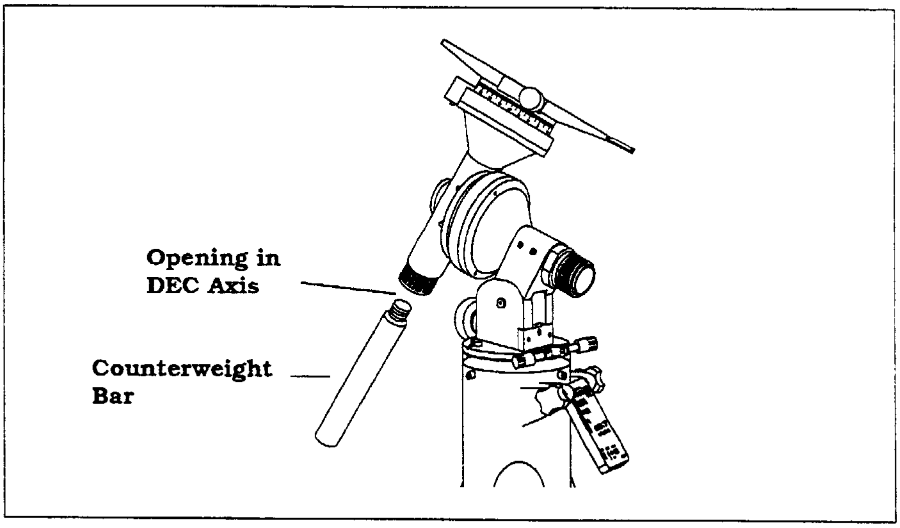


Figure 2-5

Installing the Counterweight

The Celestron CG-11 comes standard with one counterweight which weighs 22 pounds. To install the counterweight:

1. Orient the mount so that the counterweight bar points toward the ground (see figure 2-6).

2. Remove the counterweight safety thumbscrew and washer on the end of the counterweight bar (i.e., opposite the end that attaches to the mount).

3. Loosen the set screw on the side of the counterweight.

4. Slide the counterweight onto the shaft.

5. Tighten the set screw on the side of the weight to hold the counterweight in place.

6. Replace the counterweight safety thumbscrew and washer.

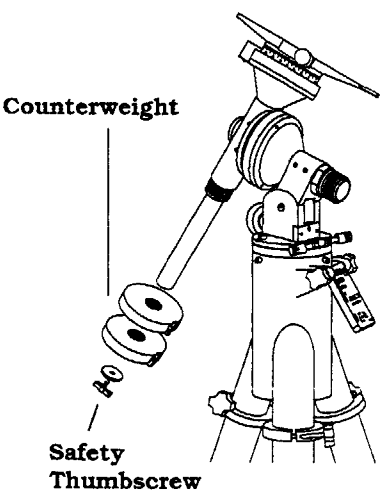


Figure 2-6

Although the illustration shows two counterweights, the CG-11comes with one 22 pound counterweight.

Attaching the Celestron CG-11 to the Mount

The telescope attaches to the mount via a dovetail bar which is mounted on the bottom of the telescope. Before you attach the optical tube, make sure that the declination and right ascension clutch knobs are tight. This will ensure that the mount does not move suddenly while attaching the telescope. To mount the telescope tube:

1. Locate the knobs on the bottom of the dovetail bar.
2. Remove the knob closest to the rear cell. This allows you to attach the telescope to the mount.
3. Loosen the knob on the side of the telescope mounting platform. This allows you to slide the dovetail bar on the telescope onto the mount.
4. Slide the dovetail bar on the telescope tube into the mounting platform of the mount. Slide the telescope so that the back of the dovetail bar is almost flush with the back of the mounting platform.
5. Tighten the knob on the side of the mounting platform to hold the telescope in place.
6. Replace the mounting knob on the bottom of the dovetail bar. These knobs are designed to keep the telescope attached to the mount in case the knob on the side of the platform comes loose.

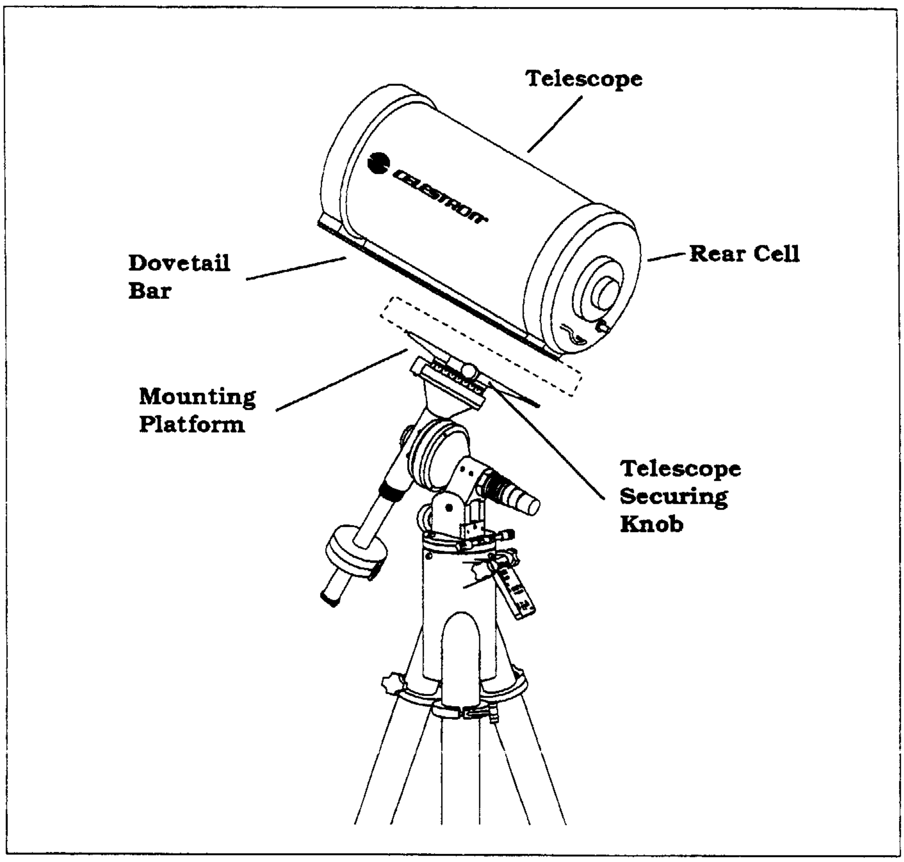


Figure 2-7

Attaching the Visual Back

The visual back is the accessory that allows you to attach all visual accessories to the telescope. To attach the visual back:

1. Remove the plastic cover on the rear cell.
2. Place the knurled slip ring on the visual back over the threads on the rear cell.
3. Hold the visual back with the set screw in a convenient position and rotate the knurled slip ring clockwise until tight.

Once this is done, you are ready to attach other accessories, such as eyepieces, diagonal prisms, etc.

If you want to remove the visual back, rotate the slip ring counterclockwise until it separates from the rear cell.

Installing the Star Diagonal

The star diagonal is a prism that diverts the light at a right angle to the light path of the telescope. This allows you to observe in positions that are physically more comfortable than if you looked straight through. To attach the star diagonal: **NOTE:** The CG-14 uses a 2" mirror diagonal.

1. Turn the set screw on the visual back until its tip no longer extends into (i.e., obstructs) the inner diameter of the visual back.
2. Slide the chrome portion of the star diagonal into the visual back.
3. Tighten the set screw on the visual back to hold the star diagonal in place.

If you wish to change the orientation of the star diagonal, loosen the set screw on the visual back until the star diagonal rotates freely. Rotate the diagonal to the desired position and tighten the set screw.

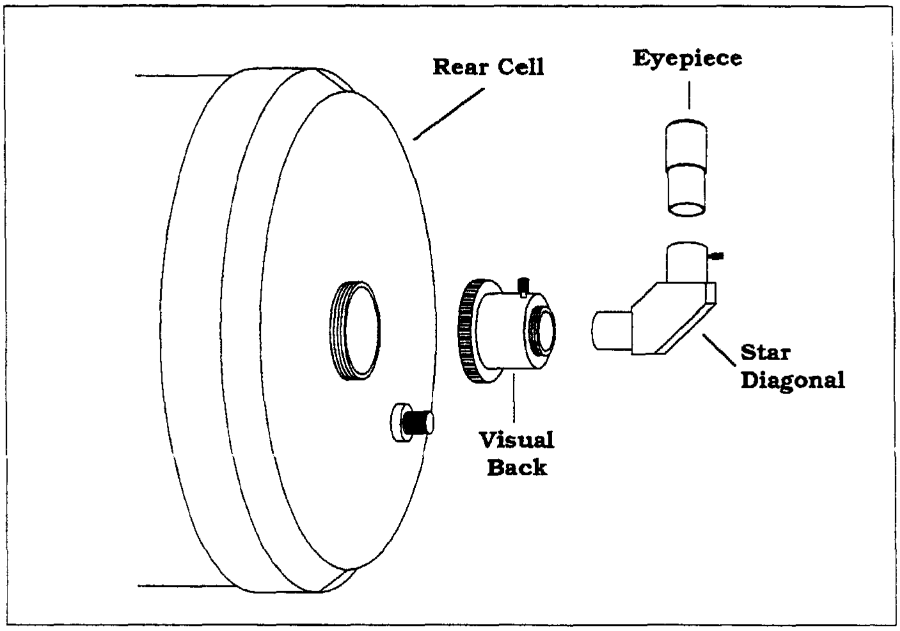


Figure 2-8

Installing the Eyepiece

The eyepiece, or ocular, is an optical element that magnifies the image focused by the telescope. The ocular(s) fit into either the visual back directly, the star diagonal, or the Erect Image Diagonal (purchased separately). To install an ocular:

1. Loosen the set screw on the star diagonal until the tip no longer extends into the inner diameter of the eyepiece end of the diagonal.

2. Slide the chrome portion of the eyepiece into the star diagonal.

3. Tighten the set screw on the star diagonal to hold the eyepiece in place.

To remove the eyepiece, loosen the set screw on the star diagonal and slide the eyepiece out. You can replace it with another ocular (purchased separately).

NOTE: The 2" mirror diagonal has a 1 1/4" eyepiece adapter to use 1 1/4" eyepieces. You may remove the adapter to use 2" eyepieces.

Eyepieces are commonly referred to by focal length and barrel diameter. The focal length of each eyepiece is printed on the eyepiece barrel. The longer the focal length (i.e., the larger the number) the lower the eyepiece power and the shorter the focal length (i.e., the smaller the number) the higher the magnification. Generally, you will use low-to-moderate power when viewing. For more information on how to determine power, see the section on "Calculating Magnification."

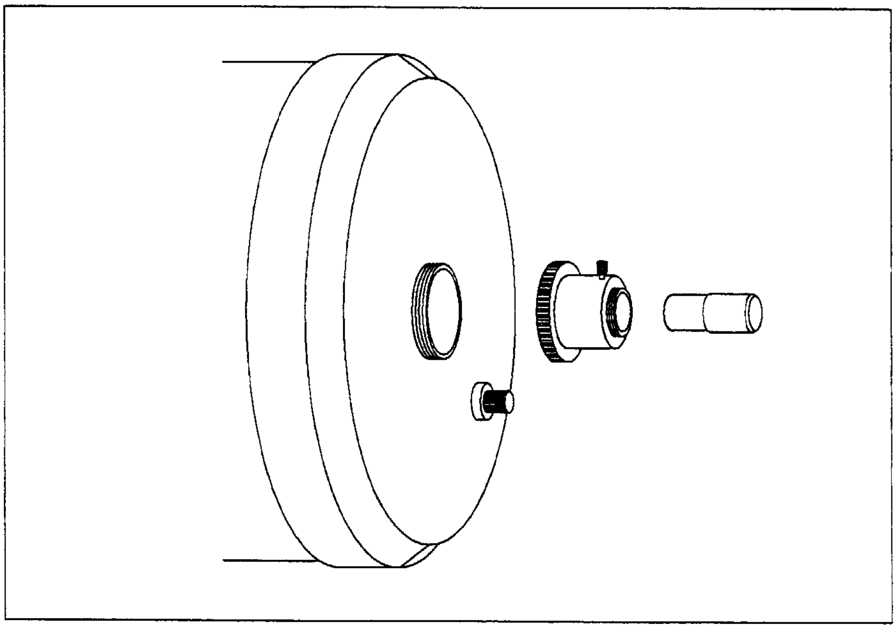


Figure 2-9

Installing the Finder

The Polaris 7x50 finder serves two basic purposes. First, it can be used as a regular finder to help you locate and center objects in the main field of your telescope. Second, it can be used to polar align your telescope. To accomplish this, the finder has a built in reticle that indicates the distance between the North Star, Polaris, and the true celestial pole. Since the finder does not come with the illuminator standard, we recommend purchasing the optional illuminator (#51614-IL). A setting plate (#60121), to show the exact position of Polaris on the reticle for the date and time you are observing, is offered as an optional accessory.

Start by removing the finder and hardware from the plastic wrapper. Included are the following:

- 7x50mm Finder
- Finder Bracket
- Rubber O-ring
- Three Nylon Tipped Thumbscrews (10-24x1/2)
- Two Allen Head Screws (8-32x1/2)

To install the finder:

1. Attach the bracket to the optical tube. To do this, place the curved portion of the bracket with the slot over the two holes in the rear cell. The bracket should be oriented so that the rings that hold the finder are over the telescope tube, not the rear cell. Start threading the screws in by hand and tighten fully with an Allen wrench.

2. Partially thread-in the three nylon-tipped thumbscrews that hold the finder in place inside the bracket. Tighten the screws until the nylon heads are flush with the inner diameter of the bracket ring. Do **NOT** thread them in completely or they will interfere with the placement of the finder. (Having the screws in place when the finder is installed will be easier than trying to insert the screws after the finder has been installed.)

3. Slide the rubber O-ring over the back of the finder (it will **NOT** fit over the objective end of the finder). It may need to be stretched a little. Once on the main body of the finder, slide it up about one inch from the end of the finder.

4. Rotate the finder until one cross hair is parallel to the R.A. axis and the other is parallel to the DEC axis.

5. Slide the eyepiece end of the finder into the front of the bracket.

6. Slightly tighten the three nylon tipped thumbscrews on the front ring of the bracket to hold the finder in place.

7. Once on, push the finder back until the O-ring is snug inside the back ring of the finder bracket.

8. Hand tighten the three nylon tipped thumbscrews until snug.

Installing the Polar Axis Finder

To aid in polar aligning the mount, Celestron offers as an optional accessory the Polar Axis Finder (#94220). It installs directly into the polar axis. To install the Polar Axis Finder:

1. Remove the polar axis end covers by rotating counterclockwise.
2. Insert the objective end of the Polar Axis Finder into the opening on the lower end of the polar axis.
3. Rotate the slip ring on the Polar Axis Finder until snug. The Polar Axis Finder should still rotate without play.

The Polar Axis Finder is now installed. If you look through the Polar Axis Finder in the daytime, the reticle is clearly visible. To see the reticle at night, however, you need to install the illuminator. To do so:

1. Remove the plastic battery holder from the battery pouch.
2. Insert two 'AA' batteries into the plastic battery holder.
3. Attach the cable with the 9-volt style battery terminal to the terminal on top of the battery holder.
4. Place the battery holder back into the battery pouch.
5. Thread the LED illuminator into the hole on the side of the polar axis finder.
6. Insert the connector on the wire which attaches to the LED into the wire connector from the battery housing. The LED will illuminate.

The Polar Axis Finder is now installed and ready to use. To turn the LED off, unplug the wire that connects the LED to the battery housing.

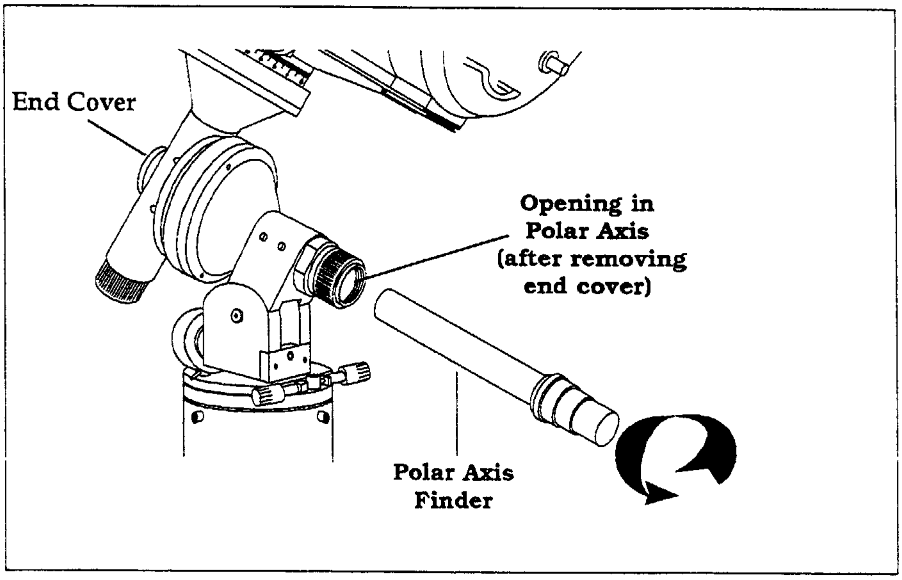


Figure 2-10

7. To focus the reticle, rotate the eyepiece of the finder until the image is sharp.

Moving the Telescope in R.A. and DEC

Once set up, you need to point your telescope at various portions of the sky to observe different objects. To make rough adjustments, loosen the R.A. and DEC clutch knobs slightly and move the telescope in the desired direction. The R.A. clutch knob is near the Polar Axis Finder while the DEC clutch knob is at the top of the counterweight bar.

For fine adjustments, use the fast-set function on the hand control box. For more information, please see the section on "Using the Drive."

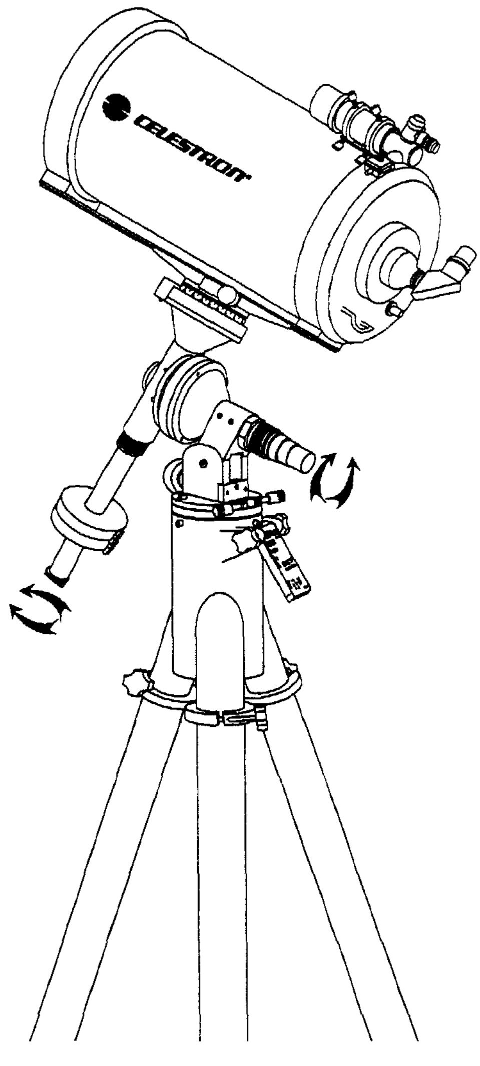


Figure 2-11

Adjusting the Mount

In order for the clock drive to track accurately, the telescope's axis of rotation must be parallel to the Earth's axis of rotation, a process known as polar alignment. Polar alignment is achieved **NOT** by moving the telescope in R.A. or DEC, but by adjusting the mount vertically, which is called altitude, and horizontally, which is called azimuth (see figure 2-12). This section simply covers the correct movement of the telescope during the polar alignment process. The actual process of polar alignment, that is making the telescope's axis of rotation parallel to the Earth's, is described later in this manual in the section on "Polar Alignment."

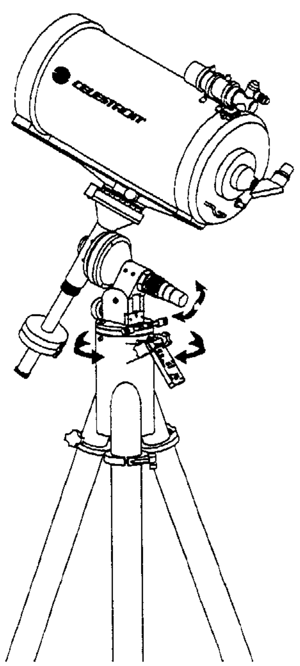


Figure 2-12

Altitude and azimuth motions of the CG-11 mount.

To adjust the mount in altitude:

1. Locate the altitude adjustment knob — it is directly below the counterweight shaft (see figure 2-13).
2. Turn the altitude adjustment knob until the mount is at the right elevation. Each complete revolution of the knob raises or lowers the polar axis 3.2°.

The altitude range is from 12° to 64°.

To adjust the mount in azimuth:

1. Locate the azimuth lock screws and adjustment knobs on the back of the mount (see figure 2-14).
2. Loosen the azimuth lock screws.
3. Turn either of the azimuth adjustment knobs until the polar axis is pointing in the right direction.
4. Tighten the azimuth lock screws to hold the mount in place.

The mount can be moved ± 8.5° in azimuth using these knobs.

Keep in mind that adjusting the mount is done during the polar alignment process only. Once polar aligned, the mount must **NOT** be moved. Pointing the telescope is done by moving the mount in right ascension and declination, as described earlier in this manual. Once the appropriate adjustments have been made and you are aligned on the celestial pole, turn the clock drive on and the telescope will track.

Figure 2-13 **Figure 2-14**

The altitude adjustment knob (figure 2-13) and the azimuth adjustment knobs (figure 2-14). The azimuth locking screws are behind the azimuth adjustment knobs.

Balancing the Mount in R.A.

To eliminate undue stress on the mount, the telescope should be properly balanced around the polar axis. Proper balancing is crucial for accurate tracking. To balance the mount:

1. Verify that the telescope securing knob on the telescope mounting platform is tight.

2. Loosen the R.A. clutch knob and position the telescope off to one side of the mount. The counterweight bar will extend horizontally on the opposite side of the mount.

3. Release the telescope — **GRADUALLY** — to see which way the telescope "rolls."

4. Loosen the set screws on the side of the counterweight so it can be moved the length of the counterweight bar.

5. Move the counterweight to a point where it balances the telescope (i.e., the telescope remains stationary when the R.A. clutch knob is loose).

6. Tighten the set screw on the counterweight to hold it in place.

While the above instructions describe a perfect balance arrangement, there should be a **SLIGHT** imbalance to ensure the best possible tracking. When the scope is on the west side of the mount the counterweight should be slightly imbalanced to the counterweight bar side. And when the tube is on the east side of the mount there should be a slight imbalance toward the telescope side. This is done so that the worm gear is pushing against a slight load. **The amount of the imbalance is very slight.** When taking astrophotographs, this balance process can be done for the specific area at which the telescope is pointing to further optimize tracking accuracy.

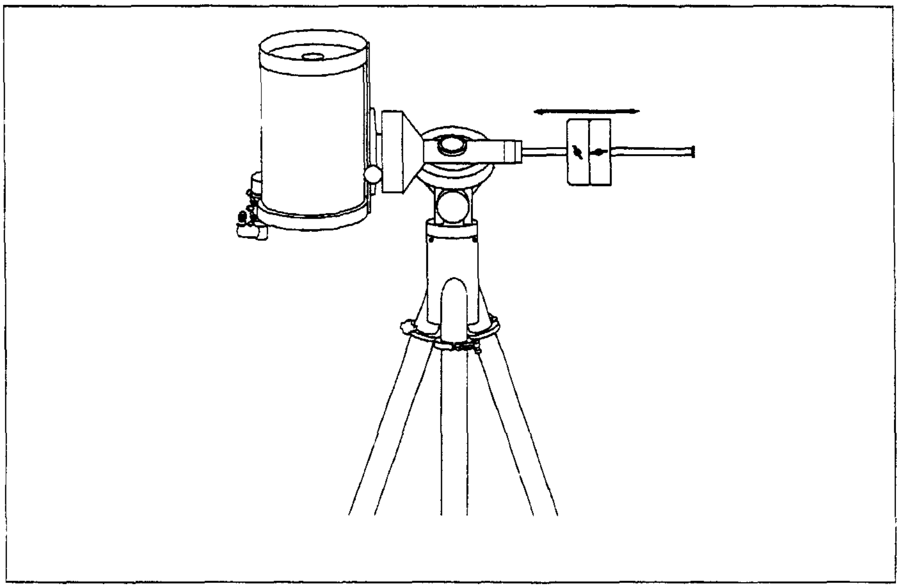


Figure 2-15

With the standard accessories attached, the counterweight should be at the far end of the counterweight bar.

Balancing the Mount in DEC

Although the telescope does not track in declination, the telescope should also be balanced in this axis to prevent any sudden motions when the DEC clutch knob is loose. To balance the telescope in DEC:

1. Loosen the R.A. clutch knob and rotate the telescope so that it is on one side of the mount (i.e., as described in the previous section on "Balancing the Mount in R.A.").

2. Tighten the R.A. clutch knob to hold the telescope in place.

3. Loosen the DEC clutch knob and rotate the telescope until the tube is parallel to the ground.

4. Release the tube — **GRADUALLY** — to see which way it rotates around the declination axis. **DO <u>NOT</u> LET GO OF THE TELESCOPE TUBE COMPLETELY!**

5. Slightly loosen the knob that holds the telescope to the mounting platform and slide the telescope either forward or backward until it remains stationary when the DEC clutch is loose. **Do NOT let go of the telescope tube while the knob on the mounting platform is loose.**

6. Tighten the knob on the telescope mounting platform to hold the telescope in place.

Like R.A. balance, these are general balance instructions and will reduce undue stress on the mount. When taking astrophotographs, this balance process should be done for the specific area at which the telescope is pointing.

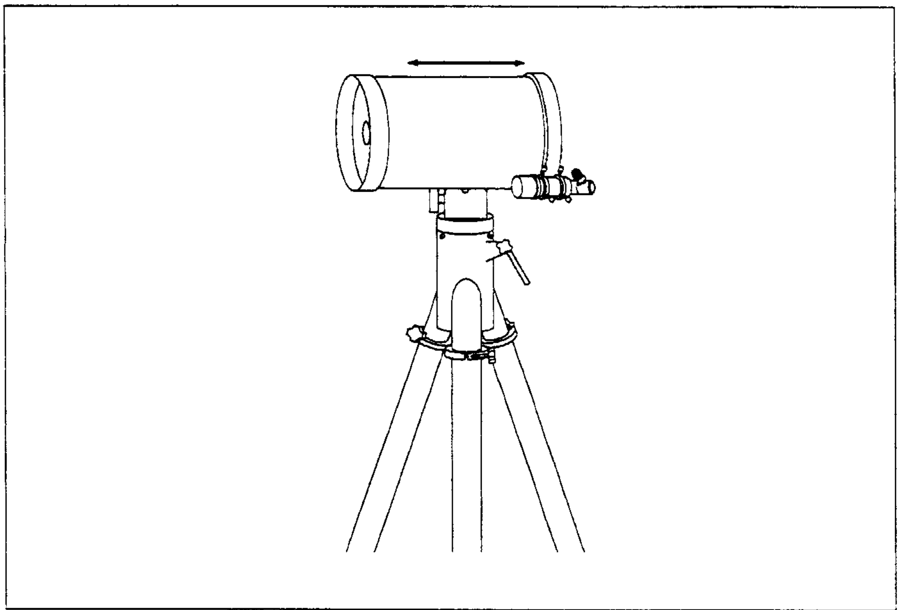


Figure 2-16

With the standard accessories attached, the end of the dovetail bar should be flush with the end of the telescope mounting platform.

Transporting Your Celestron CG-11

Because of the Celestron CG-11s size and weight, you should **ALWAYS** remove the telescope from the mount when moving the telescope. To do so:

1. Take the telescope off of the mount and return it to its carrying case.
2. Remove the counterweight from the counterweight bar.
3. Remove the counterweight bar from the mount.
4. Remove the finderscope from the optical tube.
5. Take the equatorial mount off of the central column and return it to its carrying case.
6. Remove the tripod legs from the central column.

The telescope is now broken down into enough pieces to be easily transported.

Storing Your Celestron CG-11

When not in use, your Celestron CG-11 can be left fully assembled and set up. However, all lens and eyepiece covers should be put back in place. This will reduce the amount of dust build-up on all optical surfaces and reduce the number of times you need to clean the instrument. You may want to return everything to its original shipping container and store it there. If this is the case, all optical surfaces should still be covered to prevent dust accumulation.

If you are in the field, and plan on being there for a few days, use a plastic tarp to cover the telescope and mount.

Technical Specifications

Below is pertinent technical information on your Celestron CG-11 telescope that you may find useful.

OPTICAL TUBE:	CG-11	CG-14
Optical System:	Schmidt-Cassegrain	Schmidt-Cassegrain
Aperture:	11" (279mm)	14" (356mm)
Focal Length:	2800mm (110.2")	3910mm (153.9")
F/ratio:	f/10	f/11
Highest Useful Power Magnification:	660x	840x
Lowest Useful Power Magnification:	42x	50x
Resolution (arc seconds):	0.41	0.33
Photographic Resolution:	200 lines/mm	182 lines/mm
Light Gathering Power:	1593x	2581x
Limiting Visual Magnitude:	14.7	15.3
Near Focus		
with eyepiece:	60'	175'
with camera:	60'	225'
Optical Tube Length:	25"	32"
Weight		
Optical Tube:	27.5 lbs.	45 lbs.

DEC AXIS:

- All machined stainless steel and aluminum
- One 3.75" needle thrust bearing
- Two 1.625" needle bearings
- One 2.0" needle thrust bearing
- Slip clutch-Variable friction-one knob adjustment
- 100 oz/in stepper drive - .50 arc second steps
- 5.625 diameter 7075 aluminum gear 360 tooth
- Dual supported ball bearing housed stainless steel worm - heat treated and ground
- 1.25" diameter stainless steel shaft precision ground
- Removable stainless steel counterweight shaft
- 5.0" laser engraved setting circle 1° increments
- Dovetail saddle plate - allowing for interchanging of any tube assembly - eliminates the need for DEC tube weights
- Instrument Weight to 60 pounds

POLAR AXIS:

- All machined stainless steel and aluminum
- One 3.75" needle thrust bearing
- Two 1.625" needle bearings
- One 2.0" needle thrust bearing
- Slip clutch-Variable friction-one knob adjustment
- 100 oz/in stepper drive
- 5.625 diameter 7075 aluminum gear 360 tooth
- Dual supported ball bearing housed stainless steel worm - heat treated and ground ± 5 arc second periodic error
- 1.25" diameter stainless steel shaft precision ground
- Through the axis polar axis finder - northern and southern hemisphere operation (Optional)
- Unique tangent arm design altitude adjustment 12 - 64 degrees
- Latitude scale in 2° increments
- Single knob control azimuth adjustment - bi-directional ± 8.5 degrees
- Latitude scale in 2° increments
- 5.0" laser engraved, driven setting circle (Northern Hemisphere ONLY) 4 minute increments

TRIPOD:

- All machined aluminum
- Semi-pier Tripod Design
- Removable legs with clamps
- Tripod weight approximately 20 pounds
- Weight of equatorial head 31 pounds

CONTROL SYSTEM:

- Diamond push button pattern
- R.A. and DEC reversing switches
- Three photo guide rates ± 30%, 50%, and 2x sidereal rate
- Three setting rates; 4x, 8x, 16x sidereal rate
- Quartz tracking rates; sidereal, solar, lunar, King
- Periodic Error Correction (PEC)
- Control Panel Dimmer
- Accepts Auto-Guider Systems
- Northern and Southern Hemisphere operation
- TVC - Programmable DEC Backlash Compensation
- 12 Volt DC - 500 MA power use
- Tiltable control panel for easy access
- Small hand control box for comfortable use

Note: All specifications are stated for the Celestron CG telescopes using the standard accessories. Also, these specifications are approximate and subject to change without notice.

TELESCOPE BASICS

Once your telescope is fully assembled, you are ready for your first look. This section deals with some of the basics of telescope operation.

Image Orientation

The image orientation changes depending on how the eyepiece is inserted into the telescope. When using the star diagonal, the image is right-side-up, but reversed from left-to-right (i.e., reverted). If inserting the eyepiece directly into the visual back (i.e., without the star diagonal), the image is upside-down and reversed from left-to-right (i.e., inverted). This is normal for the Schmidt-Cassegrain design and applies to the telescope's finder as well.

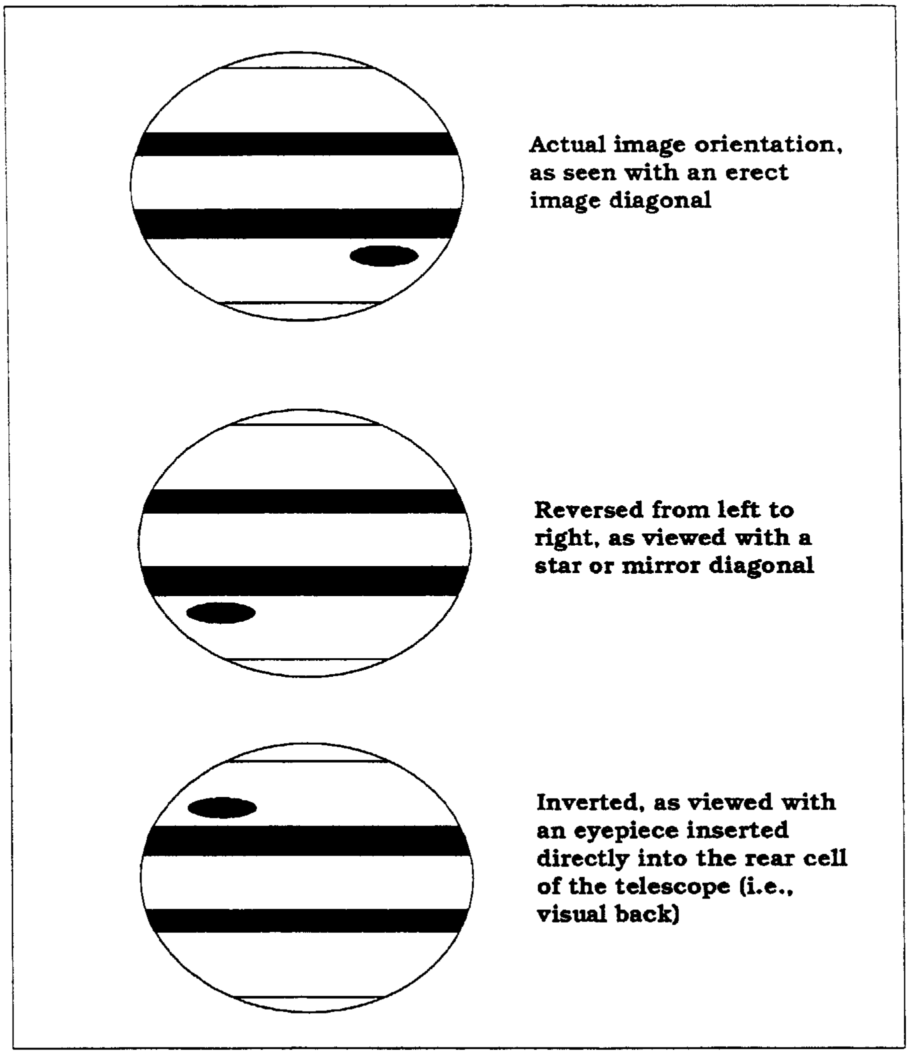


Figure 3-1

These simplified drawings of the planet Jupiter illustrate the different image orientations obtained when using various viewing configurations.

Focusing

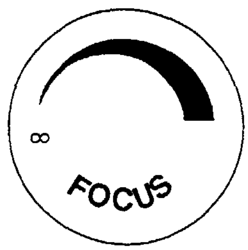


Figure 3-2

The decal on the end of the focus knob shows the correct rotational direction for focusing the CG-11.

The Celestron CG-11 focusing mechanism controls the primary mirror which is mounted on a ring which slides back and forth on the primary baffle tube. The focusing knob, which moves the primary mirror, is on the rear cell of the telescope just right of the star diagonal and eyepiece. Turn the focusing knob until the image is sharp. If the knob will not turn, it has reached the end of its travel on the focusing mechanism. Turn the knob in the opposite direction until the image is sharp. Once an image is in focus, turn the knob clockwise to focus on a closer object and counterclockwise for a more distant object. A single turn of the focusing knob moves the primary mirror only slightly. Therefore, it will take many turns (about 40) to go from close focus (approximately 65 feet) to infinity.

For critical focusing, both visually and photographically, turn the focus knob counterclockwise until the image is sharp. Turning the focusing knob in this direction pushes the primary mirror forward, or against the pull of gravity, which minimizes any mirror shift.

When working with any optical instrument, there are a few things to remember to ensure you get the best possible image.

- Never look through window glass. Glass found in household windows is optically imperfect, and as a result, may vary in thickness from one part of a window to the next. This inconsistency can and will affect the ability to focus your telescope. In most cases you will not be able to achieve a truly sharp image. In some cases, you may actually see a double image.

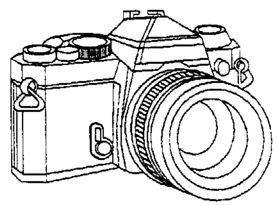
- Never look across or over objects that are producing heat waves. This includes asphalt parking lots on hot summer days or building rooftops.

- Hazy skies, fog, and mist can also make it difficult to focus when viewing terrestrially. The amount of detail seen under these conditions is greatly reduced. Also, when photographing under these conditions, the processed film may come out a little grainier than normal with lower contrast.

- When using your telescope as a telephoto lens, the split screen or microprism focuser of the 35mm SLR camera may "black out." This is common with all long focal length lenses. If this happens, use the ground glass portion of your focusing screen. To achieve a very sharp focus you may consider using a focusing magnifier. (These are readily available from your local camera store.)

- If you wear corrective lenses (specifically glasses), you may want to remove them when observing with an eyepiece attached to the telescope. When using a camera, however, you should always wear corrective lenses to ensure the sharpest possible focus. If you have astigmatism, corrective lenses must be worn at all times.

General Photography Hints



Your Celestron CG-11 can be used for both terrestrial and astronomical photography. Your Celestron CG-11 has a fixed aperture and, as a result, a fixed f/ratio. To properly expose your subjects photographically you need to set your shutter speed accordingly. Most 35mm single lens reflex (SLR) cameras offer through-the-lens metering which lets you know if your picture is under or over-exposed. This is more of a consideration when doing terrestrial photography, where exposure times are measured in fractions of a second. In astrophotography, the exposures are much longer, requiring that you use the "B" setting on your camera. The actual exposure time is determined by how long you keep the shutter open.

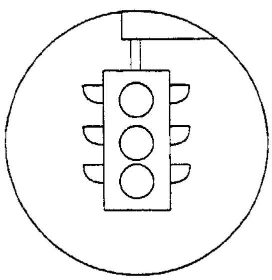
To reduce vibration when tripping the shutter, use a cable release. Releasing the shutter manually can cause vibration, something that produces blurred photos. A cable release will keep your hands clear of the camera and telescope, thus reducing the possibility of shaking the telescope. Mechanical shutter releases can be used, though air type releases are best.

Aligning the Finder

The Celestron CG-11 comes with an 7x50mm finder which helps in aiming the main telescope at distant objects that are hard to find in the narrow field of the telescope. The first number used to describe the finder is the power while the second number is the diameter of the objective lens in millimeters. This means the 7x50 finder is 7 power and has a 50mm objective lens. Incidentally, power is always compared to the unaided human eye. So a 7 power finder magnifies images seven times more than the human eye.

To make the alignment process a little easier, you should perform this task in the daytime when it is easier to locate objects in the telescope without the finder. To align the finder:

1. Choose a conspicuous object that is in excess of one mile away. This will eliminate any possible parallax effect.
2. Point your telescope at the object you selected and center it in the main optics of the telescope.
3. Check the finder to see where it is located in the field of view.
4. Adjust the screws on the finder bracket, tightening one while loosening another, until cross hairs are centered on the target.
5. Tighten each set screw a quarter of a turn to ensure that they will not come loose easily.



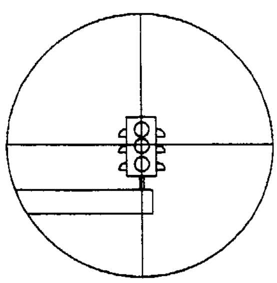


Figure 3-3

TOP: The image as seen through the telescope. BOTTOM: The image as seen through the finder.

Your First Look

With the telescope fully assembled and all the accessories attached, you are ready for your first look. Your first look should be done in the daytime when it is easier to locate the locking clutches. This will help to familiarize you with your telescope, thus making it easier to use at night.

Daytime Observing

As mentioned in the introduction, your Celestron CG-11 telescope works well as a terrestrial spotting scope. When not used to examine objects in the night sky, it can be used to study objects here on Earth.

WARNING !

NEVER POINT YOUR TELESCOPE AT THE SUN UNLESS YOU HAVE THE PROPER SOLAR FILTER. PERMANENT AND IRREVERSIBLE EYE DAMAGE MAY RESULT AS WELL AS DAMAGE TO YOUR TELESCOPE. ALSO, NEVER LEAVE YOUR TELESCOPE UNATTENDED DURING A DAYTIME OBSERVING SESSION, ESPECIALLY WHEN CHILDREN ARE PRESENT.

1. Find a distant object that is fairly bright.
2. Insert a low power eyepiece (one with a large focal length) into the telescope.
3. Adjust the R.A. and DEC clutch knobs if needed and point the telescope in the direction of the object you selected.
4. Locate the object in your finder.
5. Move the telescope — by hand — until the object is centered in the finder.
6. Look through the main optics and the object will be there (if you aligned the finder first).

Try using different optional eyepieces to see how the field changes with various magnifications.

Nighttime Observing

Looking at objects in the sky is quite different than looking at objects on Earth. For one, many objects seen in the daytime are easy to see with the naked eye and can be located in the telescope by using landmarks. In the night sky many objects are not visible to the naked eye. To make things easier, you are better off starting with a bright object like the Moon or one of the planets.

1. Orient the telescope so that the polar axis is pointing as close to true north as possible. You can use a landmark that you know faces north to get you in the general direction.
2. Adjust the tripod legs until the mount is level.
3. Adjust the mount until the latitude indicator points to the latitude of the site from which you are observing.
4. Insert a low power eyepiece (i.e., one with a large focal length) into the telescope to give you the widest field possible.
5. Turn the clock drive on.
6. Loosen the right ascension and declination clutch knobs and point the telescope at the desired target. The Moon or one of the brighter planets is an ideal first target.
7. Locate the object in the finder, center it, and then look through the telescope.
8. Turn the focus knob until the image is sharp.
9. Take your time and study your subject. If observing the Moon, look for small details in the craters.

That's all there is to using your Celestron CG-11. However, don't limit your view of an object to a single eyepiece. After a few minutes, try using a different optional eyepiece, a more powerful one. This gives you an idea of how the field of view changes. Center your target and focus. Once again, if observing the Moon you will be looking at a few craters at the same time.

NOTE: If not using the clock drive, the stars will appear to drift out of the field of view. This is due to the Earth's rotation. In fact, anything in the sky, day or night, will drift out unless the telescope has been polar aligned and the clock drive is running. There is more on this in the section on "Polar Alignment."

Calculating Magnification

You can change the power of your Celestron CG-11 telescope just by changing the eyepiece (ocular). To determine the magnification of your Celestron CG-11, simply divide the focal length of the telescope by the focal length of the eyepiece used. In equation format, the formula looks like this:

$$\text{Magnification} = \frac{\text{Focal Length of Telescope (mm)}}{\text{Focal Length of Eyepiece (mm)}}$$

Let's say, for example, that you are using the standard 26mm eyepiece. To determine the magnification you simply divide the focal length of your Celestron CG-11 (2800mm) by the focal length of the eyepiece (26mm). Dividing 2800 by 26 yields a magnification of 108 power.

Although the power is variable, each instrument — under average skies — has a limit to the highest useful magnification. The general rule is that 60 power can be used for every inch of aperture. For example, the Celestron CG-11 is 11" in diameter. Multiplying 11 by 60 gives a maximum useful magnification of 660 power. Although this is the maximum useful magnification, most observing is done in the range of 20 to 35 power for every inch of aperture which is 220 to 385 times for the CG-11.

Determining Field of View

Determining the field of view is important if you want to get an idea of the angular size of the object you are observing. To calculate the actual field of view, divide the apparent field of the eyepiece (supplied by the eyepiece manufacturer) by the magnification. In equation format, the formula looks like this:

$$\text{True Field} = \frac{\text{Apparent Field of Eyepiece}}{\text{Magnification}}$$

As you can see, before determining the field of view, you must figure the magnification. Using the example in the previous section, we can determine the field of view using the same 26mm eyepiece. The 26mm Plössl eyepiece has an apparent field of view of 50°. Divide the 50° by the magnification, which is 108 power. This yields an actual field of .46°, or about one half of a degree.

To convert degrees to feet at 1,000 yards, which is more useful for terrestrial observing, simply multiply by 52.5. Continuing with our example, multiply the angular field .46° by 52.5. This produces a linear field width of 24.2 feet at a distance of one thousand yards.

The apparent field of each eyepiece that Celestron manufactures is found in the Celestron Accessory Catalog (#93685).

The following section deals with observational astronomy in general. It includes information on the night sky, polar alignment, and using your telescope for astronomical observing.

The Celestial Coordinate System

In order to help find objects in the sky, astronomers use a celestial coordinate system which is similar to our geographical coordinate system here on Earth. The celestial coordinate system has poles, lines of longitude and latitude, and an equator. For the most part, these remain fixed against the background stars.

The celestial equator runs 360 degrees around the Earth and separates the northern celestial hemisphere from the southern. Like the Earth's equator, it bears a reading of zero degrees. On Earth this would be latitude. However, in the sky this is referred to as declination, or DEC for short. Lines of declination are named for their angular distance above and below the celestial equator. The lines are broken down into degrees, minutes and seconds of arc. Declinations south of the equator carry a minus sign (-) in front of the coordinate and those north of the celestial equator are either blank (i.e., no designation) or preceded by a plus sign (+).

The celestial equivalent of longitude is called Right Ascension, or R.A. for short. Like the Earth's lines of longitude, they run from pole to pole and are evenly spaced 15 degrees apart. Although the longitude lines are separated by an angular distance, they are also a measure of time. Each line of longitude is one hour apart from the next. Since the Earth rotates once every 24 hours, there are 24 lines total. As a result, the R.A. coordinates are marked off in units of time. It begins with an arbitrary point in the constellation of Pisces designated as 0 hours, 0 minutes, 0 seconds. All other points are designated by how far (i.e., how long) they lag behind this coordinate after it passes overhead moving towards the west.

Your Celestron CG-11 telescope comes equipped with setting circles that translate the celestial coordinates into a precise location for the telescope to point. The setting circles will not work properly until you have polar aligned the telescope and aligned the R.A. setting circle.

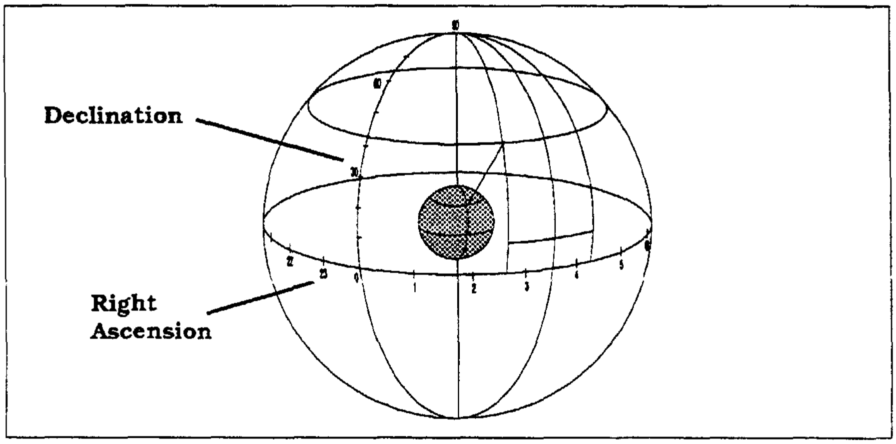


Figure 4-1

The celestial sphere seen from the outside showing R.A. and DEC.

Motion of the Stars

The daily motion of the Sun across the sky is familiar to even the most casual observer. This daily trek is not the Sun moving as early astronomers thought, but the result of the Earth's rotation. The Earth's rotation also causes the stars to do the same, scribing out a large circle as the Earth completes one rotation. The size of that circular path a star follows depends on where it is in the sky. Stars near the celestial equator form the largest circles rising in the east and setting in the west. Moving toward the north celestial pole, the point around which the stars in the northern hemisphere appear to rotate, these circles become smaller. Stars in the mid-celestial latitudes rise in the northeast and set in the northwest. Stars at high celestial latitudes are always above the horizon, and are said to be circumpolar because they never rise and never set. You will never see the stars complete one circle because the sunlight during the day washes out the starlight. However, part of this circular motion of stars in this region of the sky can be seen by setting up a camera on a tripod and opening the shutter for a couple hours. The processed film will reveal semicircles that revolve around the pole. (This description of stellar motions also applies to the southern hemisphere except all stars south of the celestial equator move around the south celestial pole.)

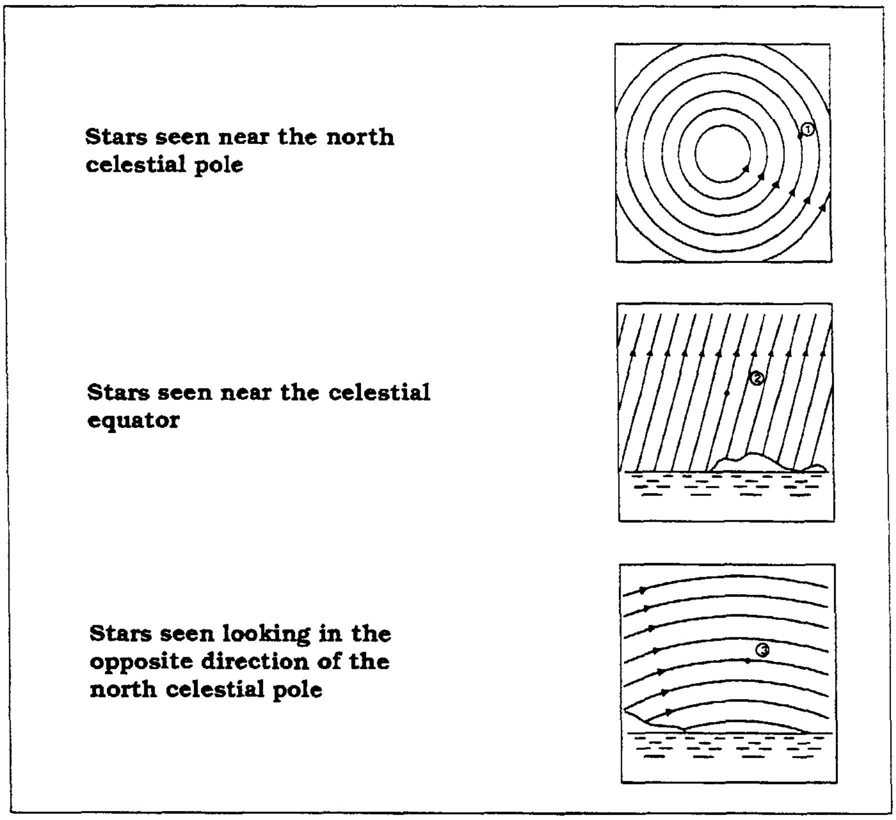


Figure 4-2

All stars appear to rotate around the celestial poles. However, the appearance of this motion varies depending on where you are looking in the sky. Near the north celestial pole the stars scribe out recognizable circles centered on the pole (1). Stars near the celestial equator also follow circular paths around the pole. But, the complete path is interrupted by the horizon. These appear to rise in the east and set in the west (2). Looking toward the opposite pole, stars curve or arc in the opposite direction scribing a circle around the opposite pole (3).

Polar Alignment

In order for the telescope to track the stars, you must meet two criteria. First, you need a drive motor that moves at the same rate as the stars. The Celestron CG-11 comes standard with a built-in drive motor designed specifically for this purpose. The second thing you need is to set the telescope's axis of rotation so that it tracks in the right direction. Since the motion of the stars across the sky is caused by the Earth's rotation about its axis, the telescope's axis must be made parallel to the Earth's.

Polar alignment is the process by which the telescope's axis of rotation (called the polar axis) is aligned (made parallel) with the Earth's axis of rotation. Once aligned, a telescope with a clock drive will track the stars as they move across the sky. The result is that objects observed through the telescope appear stationary (i.e., they will not drift out of the field of view). If not using the clock drive, all objects in the sky (day or night) will slowly drift out of the field. This motion is caused by the Earth's rotation. Even if you are not using the clock drive, polar alignment is still desirable since it will reduce the number of corrections needed to follow an object and limit all corrections to one axis (R.A.). There are several methods of polar alignment, all of which work on a similar principle, but performed somewhat differently. Each method is considered separately, beginning with the easier methods and working to the more difficult.

Although there are several methods mentioned here, you will never use all of them during one particular observing session. Instead, you may use only one if it is a casual observing session. Or, you may use two methods, one for rough alignment followed by a more accurate method if you plan on doing astrophotography.

Definition:

The polar axis is the axis around which the telescope rotates when moved in right ascension. This axis points the same direction even when the telescope moves in right ascension.

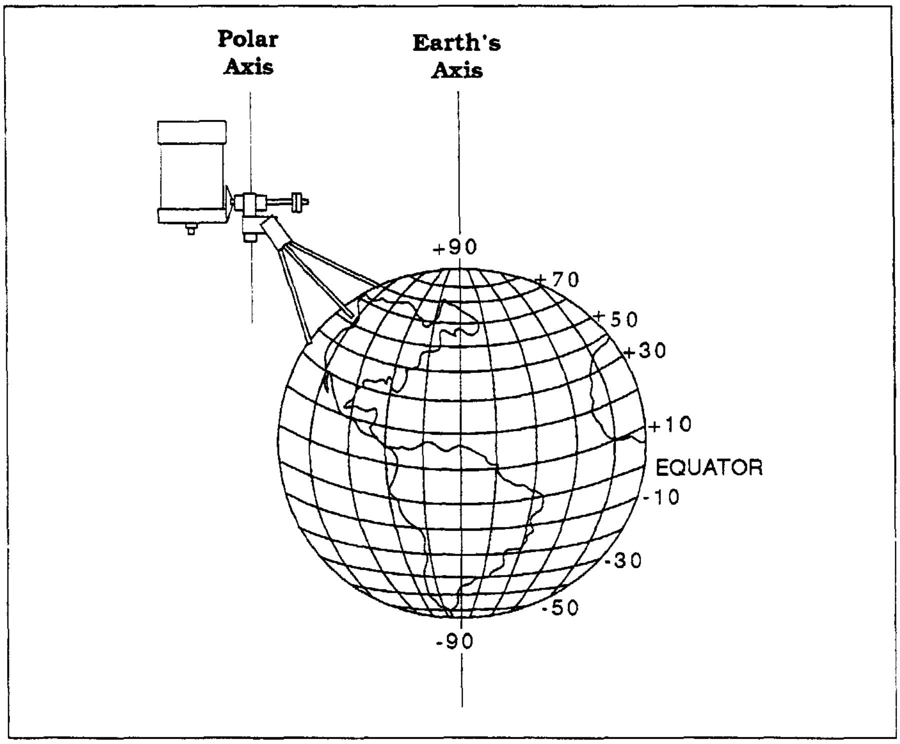


Figure 4-3

Finding the Pole

In each hemisphere, there is a point in the sky around which all the other stars appear to rotate. These points are called the celestial poles and are named for the hemisphere in which they reside. For example, in the northern hemisphere all stars move around the north celestial pole. When the telescope's polar axis is pointed at the celestial pole, it is parallel to the Earth's rotational axis.

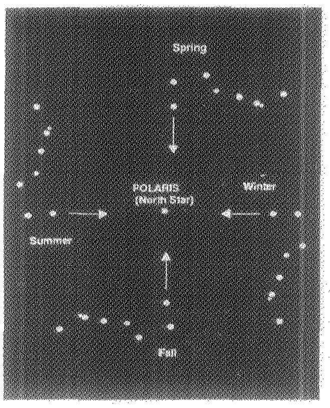


Figure 4-4

The position of the Big Dipper changes throughout the year and throughout the night.

Many of the methods of polar alignment require that you know how to find the celestial pole by identifying stars in the area. For those in the northern hemisphere, finding the celestial pole is not too difficult. Fortunately, we have a naked eye star less than a degree away. This star, Polaris, is the end star in the handle of the Little Dipper. Since the Little Dipper (technically called Ursa Minor) is not one of the brightest constellations in the sky, it may be difficult to locate from urban areas. If this is the case, use the two end stars in the bowl of the Big Dipper (the pointer stars). Draw an imaginary line through them toward the Little Dipper. They point to Polaris. The position of the Big Dipper changes during the year and throughout the course of the night. When the Big Dipper is low in the sky (i.e., near the horizon), it may be difficult to locate.

Observers in the southern hemisphere are not as fortunate as those in the northern hemisphere. The stars around the south celestial pole are not nearly as bright as those around the north. The closest star that is relatively bright is Sigma Octantis. This star is just within naked eye limit (magnitude 5.5) and lies about 59 arc minutes from the pole. For more information about stars around the south celestial pole, please consult a star atlas.

Definition:

The north celestial pole is the point in the northern hemisphere around which all stars appear to rotate. The counterpart in the southern hemisphere is referred to as the south celestial pole.

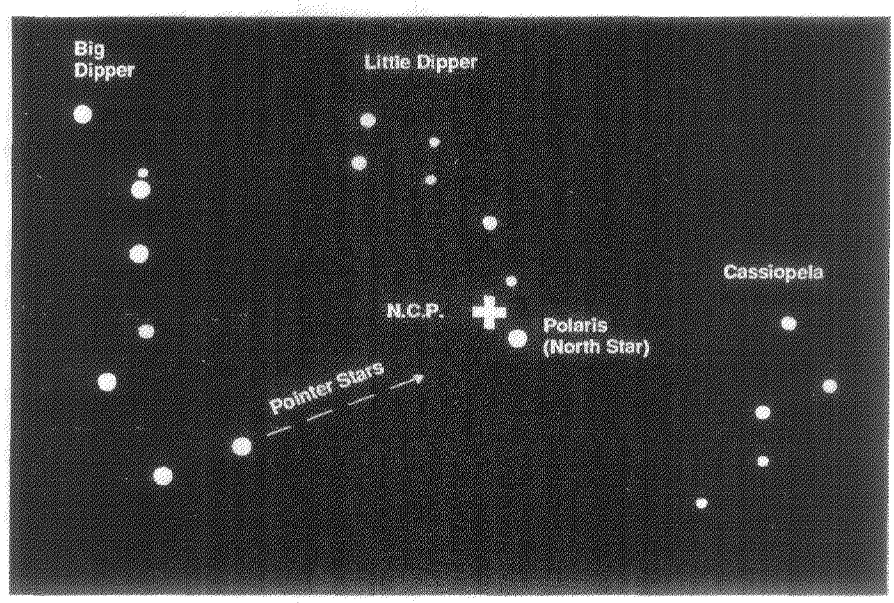


Figure 4-5

The two stars in the front of the bowl of the Big Dipper point to Polaris which is less than one degree from the true (north) celestial pole. Cassiopia, the "W" shaped constellation is on the opposite side of the pole from the Big Dipper. The North Celestial Pole (N.C.P.) is marked by the "+" sign.

Pointing at Polaris

This method utilizes Polaris as a guidepost to the celestial pole. Since Polaris is less than a degree from the celestial pole, you can simply point the polar axis of your telescope at Polaris. Although this is by no means perfect alignment, it does get you within one degree. Unlike the previous method, this must be done in the dark when Polaris is visible.

1. Set the telescope up so that the polar axis is pointing north.

2. Loosen the DEC clutch knob and move the telescope so that the tube is parallel to the polar axis. When this is done, the declination setting circle will read +90°. If the declination setting circle is not aligned, move the telescope so that the tube is parallel to the polar axis.

3. Adjust the mount in altitude and/or azimuth until Polaris is in the field of view of the finder.

4. Center Polaris in the field of the telescope using the fine adjustment controls on the mount.

   Remember, while Polar aligning, do NOT move the telescope in R.A. or DEC. You do not want to move the telescope itself, but the polar axis. The telescope is used simply to see where the polar axis is pointing.

Like the previous method, this gets you close to the pole but not directly on it. The following methods help improve your accuracy for more serious observations and photography.

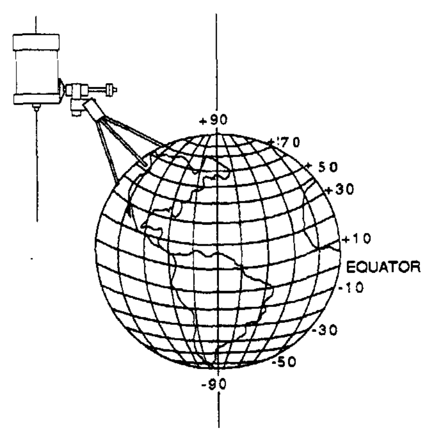


Figure 4-7

One might think that pointing at the pole produces a parallax effect, thus skewing the telescope's axis of rotation with that of the Earth's. Polaris, however, is over 50 light years away, thus making any parallax effect negligible. (One light year is 6.4 trillion miles. To find the distance to Polaris in miles, multiply 6.4 trillion by 50!)

The Polar Axis Finder

The Polar Axis Finder is designed to minimize polar alignment time while maintaining maximum accuracy. The installation of this accessory is described in the section on "Installing the Polar Axis Finder." Although this is an optional accessory, its use is described here. Here's how to use it:

1. Turn the Polar Axis Finder illuminator on.
2. Place Polaris in the field of the polar axis finder by adjusting the mount in altitude and azimuth.
3. Rotate the polar scope until the orientation of the stars on the reticle matches the star pattern in the sky (as seen with the naked eye).
4. Adjust the mount in altitude and azimuth until Polaris is in the small space on the line between Eta (η) Ursa Majoris and Epsilon (ε) Cassiopeia.
5. Note the second brightest star in the field.
6. Place this star in the space on the line between Cassiopeia and the bowl of the Big Dipper. If you can not get Polaris and this second star in their respective places, rotate the polar axis finder until you can.

When finished, the mount is accurately polar aligned.

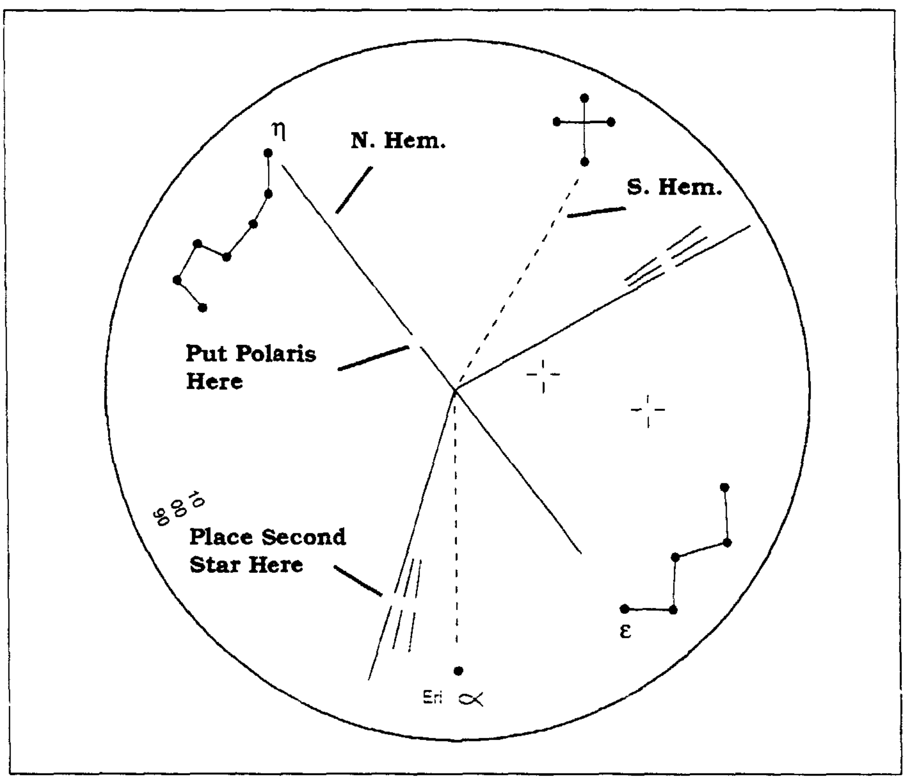


Figure 4-8

The Polar Axis Finder reticle. The correct orientation is determined by matching the naked eye view of the constellations shown and then rotating the reticle to match the view.

Declination Drift

This method of polar alignment allows you to get the most accurate alignment on the celestial pole and is required if you want to do long exposure deep-sky astrophotography through the telescope. The declination drift method requires that you monitor the drift of selected guide stars. The drift of each guide star tells you how far away the polar axis is pointing from the true celestial pole and in what direction. Although declination drift is quite simple and straightforward, it requires a great deal of time and patience to complete when first attempted. The declination drift method should be done after any one of the previously mentioned methods has been completed.

To perform the declination drift method you need to choose two bright stars. One should be near the eastern horizon and one due south near the meridian. Both stars should be near the celestial equator (i.e., 0° declination). You will monitor the drift of each star one at a time and in declination only. While monitoring a star on the meridian, any misalignment in the east-west direction will be revealed. While monitoring a star near the east/west horizon, any misalignment in the north-south direction will be revealed. As for hardware, you will need an illuminated reticle ocular to help you recognize any drift. For very close alignment, a Barlow lens is also recommended since it increases the magnification and reveals any drift faster.

When looking due south with the scope on the side of the mount, insert the diagonal so it points straight up. Insert a cross hair ocular and align the cross hairs to be parallel to declination and right ascension motion. Use ± 16x guide setting to check parallelism.

First choose your star near where the celestial equator and the meridian meet. The star should be approximately ±1/2 hour of the meridian and ±5 degrees of the celestial equator. Center the star in the field of your telescope and monitor the drift in declination.

- If the star drifts south, the polar axis is too far east.
- If the star drifts north, the polar axis is too far west.

Make the appropriate adjustments to the polar axis to eliminate any drift. Once you have managed to eliminate all drift, move to the star near the eastern horizon. The star should be 20 degrees above the horizon and ± 5 degrees of the celestial equator.

- If the star drifts south, the polar axis is too low.
- If the star drifts north, the polar axis is too high.

Once again, make the appropriate adjustments to the polar axis to eliminate any drift. Unfortunately, the latter adjustments interact with the prior adjustments ever so slightly. So, repeat the process again to improve the accuracy checking both axes for minimal drift. Once the drift has been eliminated, the telescope is very accurately aligned. You will now be able to do prime focus deep-sky astrophotography for long periods.

NOTE: If the eastern horizon is blocked, you may choose a star near the western horizon. However, you will have to reverse the polar high/low error directions. If using this method in the southern hemisphere, the procedure is the same as described above. However, the direction of drift is reversed.

Aligning the R.A. Setting Circle

Before you can use the setting circles to find objects in the sky, you need to align both the R.A. and DEC setting circle. In order to align the setting circle, you need to know the names of a few of the brightest stars in the sky. If you don't, they can be learned by using the Celestron Sky Maps (#93722) or consulting a current astronomy magazine. To align the R.A. setting circle:

1. Locate a bright star near the celestial equator. The farther you are from the celestial pole, the better your reading of the R.A. setting circle. The star you choose to align the setting circle with should be a bright one whose coordinates are known and easy to look up. (For a list of bright stars to align the R.A. setting circle, see the list at the back of this manual.)

2. Center the star in the finder.

3. Center the star in the field of the telescope.

4. Start the clock drive so that the mount tracks the star.

5. Look up the coordinates of the star. You can consult a star catalog or use the list at the end of this manual.

6. Rotate the circle until the proper coordinates line up with the R.A. indicator. The R.A. setting circle should rotate freely. The R.A. setting circle has a marker every four minutes with each hour labeled (see figure 4-10).

The R.A. setting circle is now aligned and ready to use. The R.A. setting circle is clutched to the R.A. gear rotation. As long as the R.A. drive is operating, the circle does not need to be reset once indexed to the correct coordinate (i.e., once aligned). If the drive is ever turned off, then the R.A. setting circle must be reset once activated. While the R.A. setting circle tracks with the drive motor, it does not move when slewing the telescope.

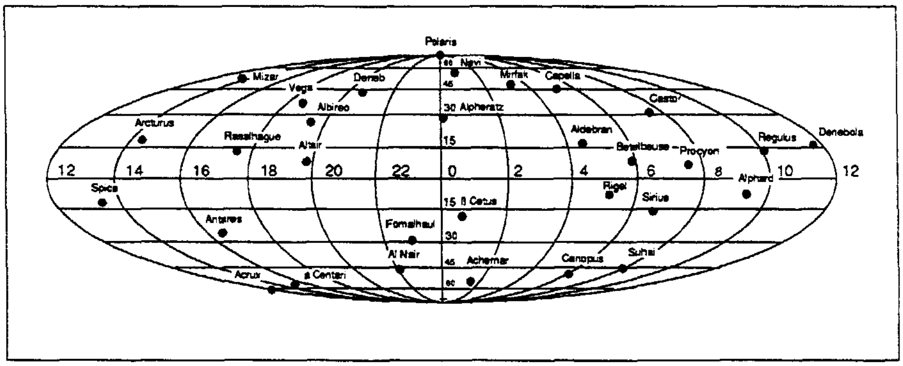


Figure 4-9

Aligning the DEC Setting Circle

After the R.A. setting circle has been aligned, you are ready to align the DEC setting circle. To align the DEC setting circle:

1. Leave the star used to align the R.A. setting circle center in the field of the telescope.
2. Look up the coordinates of the star. You can consult a star catalog or use the list at the end of this manual.
3. Locate the small Allen head screw on the DEC setting circle. It is generally located between the 0 and 10 degree marks.
4. Loosen the Allen head screw using the appropriate Allen wrench.
5. Rotate the DEC circle until the proper coordinate lines up with the DEC indicator. The DEC setting circle is scaled in degrees with a marker every two degrees (see figure 4-10).
6. Tighten the Allen screw to hold the DEC setting circle in place.

Once complete, the setting circle should not need to be aligned again unless it comes loose.

With both setting circles aligned, you are ready to use the setting circles to locate objects in the night sky. See the section on "Using the Setting Circles," for specific information.

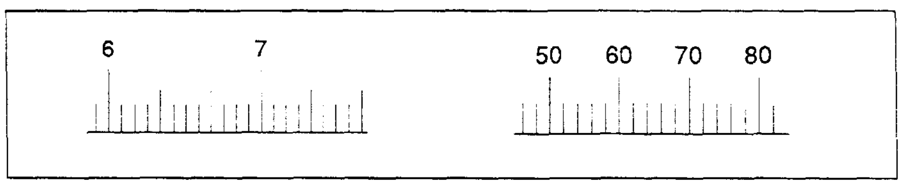


Figure 4-10

The R.A. setting circle (left) and the DEC circle (right).

The drive system uses a 5.625 diameter 7075 aluminum gear with 360 teeth for incredibly accurate tracking. One of the most unique features of the new drive is the Periodic Error Correction (PEC) function. This feature allows the drive system to "learn" the characteristics of the worm gear, and as a result, improve the tracking accuracy even more. This typically reduces the periodic error to 30 percent or less of the original error. The amount of improvement varies depending on guiding skill, atmospheric stability, the characteristics of the worm gear, and the accuracy of polar alignment.

Following is a brief discussion of each feature.

Powering Up the Drive

In order to activate the drive, you must first plug it into an external power source. To supply power to your Celestron CG-11, plug your DC or optional AC power cord into the outlet on the electronic console labeled "12 V IN." Then, plug the other end of the adapter into the appropriate power source (i.e., either AC or DC depending on the adapter used).

Next, plug the R.A. and DEC cables into the electronic box — the receptacles are on the upper right portion of the box (R.A. is on the left while DEC is on the right). Then plug the cables into the respective motors.

Once plugged into the proper power source, activate the drive by placing the ON/OFF switch in the "ON" position. Once activated, the drive begins tracking at sidereal rate, the default tracking rate. The LED below the sidereal rate icon will illuminate.

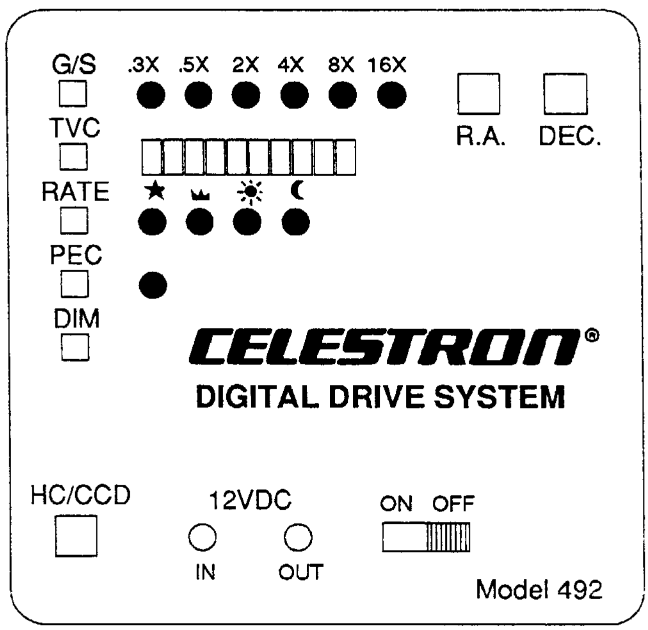


Figure 5-1

The CG-11 electronic console. To adjust the angle of the console, loosen the two knobs that hold it to the mount. Move the console to the desired position and tighten the two knobs to hold it in place.

G/S (Guide Setting)

This function allows you to select the speed at which the motor moves when corrections are made via the hand controller. Once the drive is activated, the default setting is .3 times sidereal rate. Press the button to change the guiding rate. The selections are .3x, .5x, 2x, 4x, 8x, and 16x sidereal rate.

For guiding, use either the .3x or .5x setting. These two rates allow optical use with auto guiders. The faster settings — 2x, 4x, 8x, and 16x — are perfect for positioning objects within the field of view.

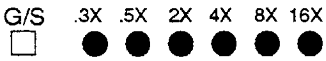


Figure 5-2

To move the telescope at the 16x speed WITHOUT changing the guide setting, press the button that corresponds to the direction you want to move the telescope. While holding the button down, press the opposite directional button. For example, if you want to move the telescope west, hold the west button down and then press the east button. Conversely, if you want to move the telescope east, hold the east button down and then press the west button. This "fast-set" function also works in declination. It should be noted that the R.A. setting circle does not remain calibrated when using any of the slewing rates.

NOTE: **If the 16x speed is not functioning (but all other speeds do), it is probably due to low voltage from your power source.**

TVC — Time Variable Backlash Correction

The TVC (Time Variable Correction) function allows you to eliminate the backlash in the DEC motor when changing directions (i.e., from north to south or vice versa). Here's how it works. Each time you change the direction of the telescope in declination, the motor speeds up momentarily to take up any slack. There are 10 settings each indicated by an illuminated green bar. The best setting is determined by looking through the eyepiece while changing the direction of the DEC motor and then moving through the TVC settings until the backlash has been eliminated.

To activate this function, press the TVC button. Once activated, the bar on the far right of the display will illuminate. Press the TVC button again, and the next bar will illuminate, and so on for all ten settings. Note that the first bar (i.e., the one on the far right) always stays illuminated while the TVC function is activated. A setting of three to six bars typically eliminates any backlash. The TVC must be reset each time you power up the drive.

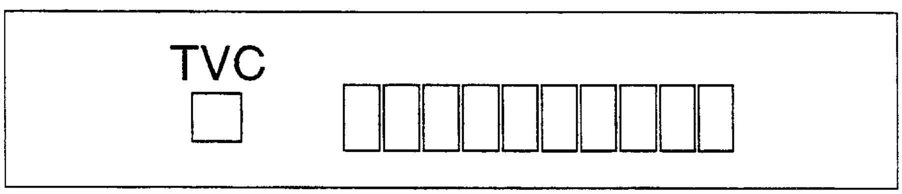


Figure 5-3

Tracking Rate Selection

The drive has four basic rates: sidereal, King (which is a modified sidereal rate that takes into account atmospheric refraction), solar, and lunar. While solar and lunar rates are obvious, sidereal and King rates require a little more explaining. Sidereal rate is based on a single rotation of the Earth which takes 1,436.5 minutes. An astronomer by the name of King discovered that atmospheric refraction affects the apparent motion of objects across the sky. The King rate takes into account this refraction caused by the Earth's atmosphere and is recommended for deep sky astrophotography. For deep sky observing, either King or sidereal rate is fine.

Each of the tracking rates is represented by an icon. Sidereal rate is represented by a star (★), King rate by a crown (♛), solar rate by a sun (☀), and lunar rate by a crescent moon (☾). Underneath each icon is an LED to indicate which rate has been selected. Once the power has been turned on, the drive tracks at sidereal rate, the default tracking rate. To change the tracking rate, press the "RATE" button. Pressing the button once changes the drive rate once. The rates are selected sequentially from left-to-right as listed above.

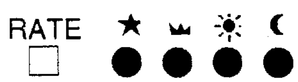


Figure 5-4

Note that the PEC function does **NOT** have to be activated for the drive to work. However, once PEC is activated, the drive rate is locked on the one selected. You can not change rates until PEC is turned off.

Periodic Error Correction (PEC)

Periodic Error Correction, or PEC for short, is a system that improves the tracking accuracy of the drive. PEC is designed to improve photographic quality by reducing the amplitude of the worm errors. Using the PEC function is a two-step process. First, you must guide for at least four minutes — keeping the guide star centered on the cross hairs of your optional guiding eyepiece — during which time the system records the corrections you make. (It takes the worm gear four minutes to make one complete revolution, hence the need to guide for four minutes.) The second step is to playback the corrections you made during the recording phase. The microcomputer inside the electronic console does this automatically after one revolution of the worm gear.

Definition:

Periodic error is a slight oscillation in right ascension caused by imperfections in all drive gears. The cycle of the periodic error is equal to the rotation of the [worm] gear, in this case four minutes. All telescope drives with gears have some periodic error. The periodic error of your Celestron CG-11 is very slight to begin with.

Keep in mind, this feature is for advanced astrophotographers and requires careful guiding. Here's how to use the PEC function most effectively.

1. Find a bright star relatively close to the object you want to photograph.

2. Insert a high power eyepiece with illuminated cross hairs into your telescope. Orient the guiding eyepiece cross hairs so that one is parallel to the declination axis while the other is parallel to the R.A. axis.

3. Center the guide star on the illuminated cross hairs, focus the telescope, and study the periodic movement.

4. Take a few minutes to practice guiding. This will help you familiarize yourself with the periodic error of the drive and the operation of the hand control box.

5. Press the "PEC" button once to activate the mode. The LED will flash once a second for 5 seconds indicating you have five seconds to get back to the eyepiece and begin guiding before it begins recording. The .3x guiding rate is best for this function.

NOTE: **The star should stay centered on the cross hairs for a few seconds without using the hand controller before activating the PEC function.**

6. Guide for four minutes. Try not to overshoot corrections in right ascension. Ignore drift in declination. During the record phase, the LED flashes a little faster.

After four minutes, the system begins to play back the corrections made during the first four minutes. When playing back, the LED stays on without blinking.

NOTE: The fast-set function is locked while the PEC function is activated. This eliminates the possibility of moving the telescope suddenly during an exposure.

Once you have used the PEC function for awhile you may mistake its operation for the way the drive normally operates. The best way to see how well the PEC function works is to turn it off. PEC results improve with practice and patience.

DIM

The DIM button changes the intensity of the LED displays. There are five brightness ranges with the default to the maximum setting. This feature allows the LEDs to be dimmed to an acceptable level so as not to be a distraction when observing and photographing.

HC/CCD

This outlet accepts the hand controller needed for guiding and moving the telescope. In addition, the outlet is wired to accept the SBIG ST-4 Auto Guider (an optional product sold by another manufacturer). This outlet uses a modular phone-type jack. Push the connector on the cable into the outlet until the plastic tab clicks. To remove the cable, squeeze the plastic tab and pull away from the outlet.

12 V DC IN

This outlet is used to supply power to the telescope. Your Celestron CG-11 comes standard with a cigarette plug type DC adapter. To install the adapter, plug the connector into the electronic box first, then the power source (automobile cigarette lighter receptacle).

12 V DC OUT

The 12 V DC OUT is for auxiliary accessories that require power. Accessories to plug into this outlet must have a 2.1mm DC power jack type.

R.A./DEC Outlets

In the upper right corner of the electronic console are two outlets; one labeled R.A. the other DEC. These outlets are for the R.A. and DEC motor cables. These outlets use a modular phone-type jack. Push the connector on the cable into the outlet until the plastic tab clicks. To remove the cable, squeeze the plastic tab and pull away from the outlet.

Northern/Southern Hemisphere Operation

When using your Celestron CG-11 in the southern hemisphere, there is a need to reverse the motors. Changing from northern hemisphere to southern hemisphere requires changing the polarity of the drive motor. To do this:

1. Remove the cover of the electronic box by removing the four screws (one in each corner).
2. Locate north/south switch (labeled N/S) just right of the ON/OFF switch.
3. Change the switch from "N" to the "S" setting.
4. Replace the cover.

The direction of the drive motor is now reversed and will work in the southern hemisphere. If going from the southern hemisphere to the northern hemisphere, simply change the switch from the "S" to "N" setting.

For quick changes, press one of the R.A. buttons while powering up the drive. Which R.A. button do you press? It depends on the directional setting of the R.A. switch (see the section on "R.A./DEC Reverse"). The best way is to do it by trial and error; press one button while powering up the drive. If it does not work, turn the drive off and try the process again while pressing the other R.A. button.

The Hand Controller

The hand controller allows you to move the telescope in R.A. and DEC using the corresponding motors. This includes fine corrections for guided astrophotography and minor adjustments for centering objects in the field of view.

The buttons on the hand controller are intentionally labeled in a rather vague manner. This is due to the fact that the direction of motion of the mount varies depending on how the telescope is oriented. Furthermore, these buttons are user definable to eliminate confusion when guiding. (For more information, see the section on "R.A./DEC Reverse.")

Once again, to move the telescope at the 16x speed **WITHOUT** changing the guide setting, press the button that corresponds to the direction you want to move the telescope. While holding the button down, press the opposite directional button. For example, if you want to move the telescope west, hold the west button down and then press the east button. Conversely, if you want to move the telescope east, hold the east button down then press the west button. The fast-set function also works in declination.

R.A./DEC Reverse

As mentioned previously, the direction a particular button moves the mount varies depending on the telescope's orientation (i.e., whether it's on the east or west side of the mount.) This can create confusion when guiding if you change the telescope's orientation during a given photographic session. To compensate for this, the direction of the R.A. and DEC buttons are changeable. To reverse the direction of either the R.A. and/or DEC buttons, change the switch setting of the appropriate axis. The switches that control these settings are found on the upper portion of the hand controller.

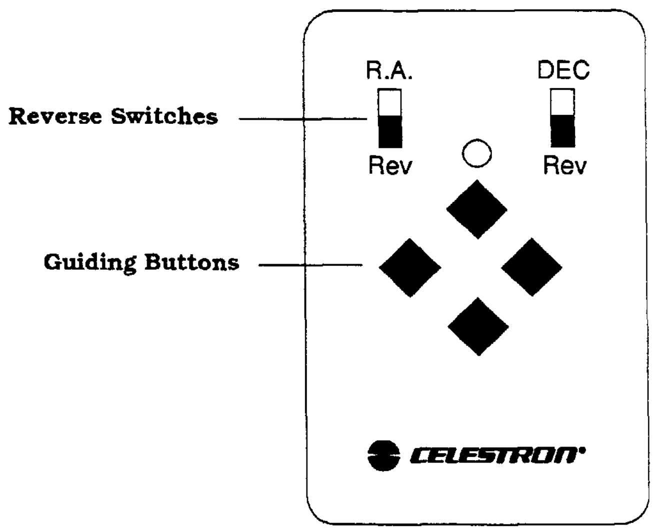


Figure 5-5

With your telescope set up, you are ready to use it for observing. This section covers visual observing of both solar system and deep-sky objects.

Observing the Moon

In the night sky, the Moon is a prime target for your first look because it is extremely bright and easy to find. Often, it is a temptation to look at the Moon when it is full. At this time, the face we see is fully illuminated and its light can be overpowering. In addition, little or no contrast can be seen during this phase.

One of the best times to observe the Moon is during its partial phases (around the time of first or third quarter). Long shadows reveal a great amount of detail on the lunar surface. At low power you will be able to see most of the lunar disk at one time. The optional Reducer/Corrector lens allows for breath-taking views of the entire lunar disk when used with a low power eyepiece. Change to higher power (magnification) to focus in on a smaller area. Keep in mind that if you are not using the clock drive, the rotation of the Earth will cause the Moon to drift out of your field of view. You will have to manually adjust the telescope to keep the Moon centered. This effect is more noticeable at higher power. If you are using the clock drive and have polar aligned, the Moon will remain centered if using the lunar tracking rate. Consult your local newspaper or a current astronomy magazine to find out when the Moon will be visible.

LUNAR OBSERVING HINTS

- To ensure accurate tracking, be sure to select the lunar tracking rate.
- Try using eyepiece filters to increase contrast and bring out more detail on the lunar surface.

Observing the Planets

Other easy targets in the night sky include the five naked eye planets. You can see Venus go through its lunar-like phases. Mars can reveal a host of surface detail and one, if not both, of its polar caps. You will be able to see the cloud belts of Jupiter and the great Red Spot (if it is visible at the time you are observing). In addition, you will also be able to see the moons of Jupiter as they orbit this gas giant. Saturn, with its beautiful rings, is easily visible at moderate power. All you need to know is where to look. Most astronomy publications tell where the planets can be found in the sky each month.

King or sidereal rates work best for tracking the planets.

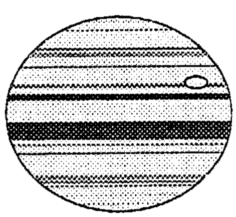


Figure 6-1

This scanned drawing of Jupiter provides a good representation of what you can expect to see with moderate magnification during good seeing conditions.

Observing the Sun

Although overlooked by many amateur astronomers, solar observation is both rewarding and fun. However, because the Sun is so bright, special precautions must be taken when observing our star so as not to damage your eyes or your telescope.

WARNING:

Never project an image of the Sun through the telescope. Because of the folded optical design, tremendous heat build-up will result inside the optical tube. This can damage the telescope and/or any accessories attached to the telescope.

For safe solar viewing, use a Celestron solar filter. These filters reduce the intensity of the Sun's light, making it safe to view. With these filters you can see sunspots as they move across the solar disk and faculae, which are bright patches seen near the Sun's edge. **Be sure to cover the lens of the finder or completely remove the finder when observing the Sun. This will ensure that the finder itself is not damaged and that no one looks through it inadvertently.**

SOLAR OBSERVING HINTS

- The best time for observing the Sun is in the early morning or late afternoon when the air is cooler.
- To locate the Sun without a finder, watch the shadow of the optical telescope tube until it forms a circular shadow.
- To ensure accurate tracking, be sure to select the solar tracking rate.

Observing Deep-Sky Objects

Deep-sky objects are simply those objects outside the boundaries of our solar system. They include star clusters, planetary nebulae, diffuse nebulae, double stars, and other galaxies outside our own Milky Way. The Celestron Sky Maps (#93722) can help you locate the brightest deep-sky objects. You can use your setting circles or "star hop" to an object from an area with which you are familiar.

Most deep-sky objects have a large angular size. Therefore, low-to-moderate power is all you need to see them. Visually, they are too faint to reveal any color seen in long exposure photographs. Instead, they have a black and white appearance. And, because of their low surface brightness, they should be observed from a dark sky location. Light pollution around large urban areas washes out most nebulae making them difficult, if not impossible, to observe. Light Pollution Reduction filters help reduce the background sky increasing contrast.

Using Your Setting Circles

Once the setting circles are aligned you can use them to find any objects with known coordinates.

1. Select an object to observe. Use a seasonal star chart or planisphere to make sure the object you chose is above the horizon. As you become more familiar with the night sky, this will no longer be necessary.

2. Look up the coordinates in an atlas or reference book.

3. Move the telescope in declination until the indicator is pointing at the correct declination coordinate.

4. Move the telescope in R.A. until the indicator points to the correct coordinate (do NOT move the R.A. circle). The telescope will track in R.A. as long as the clock drive is operating.

5. Look through the finder to see if you have located the object.

6. Center the object in the finder.

7. Look in the main optics using a low power eyepiece; the object should be there.

8. Repeat the process for each object observed throughout the observing session.

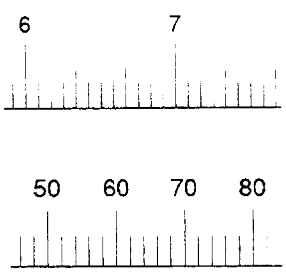


Figure 6-2

The R.A. setting circle (top) and the DEC circle (bottom).

You may not be able to see fainter objects in the finder. When this happens, gradually sweep the telescope around until the object is visible.

The declination setting circle is scaled in degrees while the R.A. setting circle is incremented in minutes with a marker every four minute (see figure 6-2). As a result, the setting circles will get you close to your target, but not directly on it. Also, the accuracy of your polar alignment will also affect how accurately your setting circles read. It should be noted that the R.A. setting circle does not remain calibrated when using any of the slewing rates.

At the end of this manual there is a list of deep-sky objects well within reach of your Celestron CG-11 telescope.

Star Hopping

Another way to find deep-sky objects is by star hopping. Star hopping is done by using bright stars to "guide" you to an object. Here are the directions for two popular objects.

The Andromeda Galaxy, M31, is an easy target. To find M31:

1. Locate the constellation of Pegasus, a large square visible in the fall and winter months.

2. Start at the star in the northeast corner. The star is Alpha (α) Andromedae.

3. Move northeast approximately 7°. There you will find two stars of equal brightness — Delta (δ) and Pi (π) Andromedae — about 3° apart.

4. Continue in the same direction another 8°. There you will find two stars — Beta (β) and Mu (μ) Andromedae — about 3° apart.

5. Move 3° northwest — the same distance between the two stars — to the Andromeda galaxy. It is easily visible in the finder.

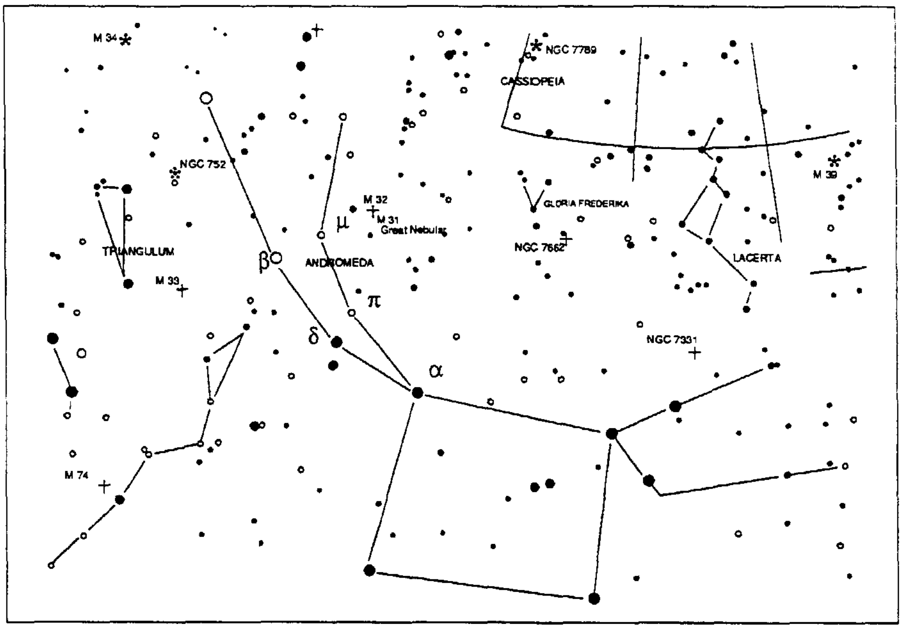


Figure 6-3

Star hopping to the Andromeda Galaxy is a snap to find since all the stars needed to do so are visible to the naked eye. Note that the scale for this star chart is different from the one on the following page which shows the constellation Lyra.

Star hopping may take some getting used to since you can see more stars through the finder than you can see with the naked eye. And, some objects are not visible in the finder. One such object is M57, the famed Ring Nebula. Here's how to find it:

1. Find the constellation of Lyra, a small parallelogram visible in the summer and fall months. Lyra is easy to pick out because it contains the bright star Vega.

2. Start at the star Vega — Alpha (α) Lyrae — and move a few degrees southeast to find the parallelogram. The four stars that make up this geometric shape are all similar in brightness making them easy to see.

3. Locate the two southernmost stars that make up the parallelogram — Beta (β) and Gamma (γ) Lyrae.

4. Point the finder half way between these two stars.

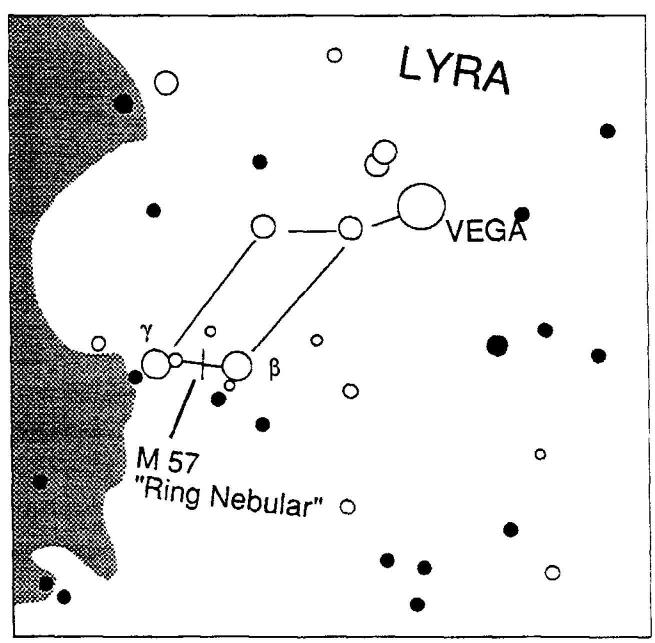
5. Move about 1/2° toward Beta (β) Lyrae, but remaining on a line that connects the two stars.

6. Look through the telescope and the Ring Nebula should be in the telescope. Its angular size is quite small and, therefore, not visible in the finder.

Because the Ring Nebula is rather faint, you may need to use averted vision to see it. Averted vision is the act of looking slightly away from the object you are observing. So, if you are observing the Ring Nebula, center it in the field of view and then look off toward the side. In this manner, light from the object is falling on the black and white sensitive rods as opposed to the color sensitive cones. These two examples should give you an idea of how to star hop to deep sky objects. To use this method on other objects, consult any of the star atlases and star hop to the object of your choice using naked eye stars.

Figure 6-4

Although the Ring Nebula lies between two naked eye stars, it may take a little time to locate since it is not visible in the finder. Note that the scale for this star chart is different from the one on the previous page which shows several constellations including Pegasus, Triangulum, and Andromeda.



Viewing Conditions

Viewing conditions affect what you can see through your CG-11 telescope during an observing session. Conditions include transparency, sky illumination, and seeing. Understanding viewing conditions and the effect they have on observing will help you get the most out of your CG-11 telescope.

Transparency

Transparency is the clarity of the atmosphere and is affected by clouds, moisture, and other airborne particles. Thick cumulus clouds are completely opaque while cirrus can be thin, allowing the light from the brightest stars through. Hazy skies absorb more light than clear skies making fainter objects harder to see and reducing contrast on brighter objects. Aerosols ejected into the upper atmosphere from volcanic eruptions also affect transparency. Ideal conditions are when the night sky is inky black.

Sky Illumination

General sky brightening caused by the Moon, aurorae, natural airglow, and light pollution greatly affect transparency. While not a problem for the brighter stars and planets, bright skies reduce the contrast of extended nebulae making them difficult, if not impossible, to see. To maximize your observing, limit deep sky viewing to moonless nights far from the light polluted skies found around major urban areas. You can, on the other hand, observe planets and stars from light polluted areas or when the Moon is out.

Seeing Conditions

Seeing conditions refer to the stability of the atmosphere and directly effects the clarity of star images and the amount of fine detail seen in extended objects. The air in our atmosphere acts as a lens which bends and distorts incoming light rays. The amount of bending depends on air density. Varying temperature layers have different densities and therefore bend light differently. Light rays from the same object arrive slightly displaced creating an imperfect or smeared image. These atmospheric disturbances vary from time-to-time and place-to-place. The size of the air parcels compared to your aperture determines the "seeing" quality. Under good seeing conditions, fine detail is visible on the brighter planets like Jupiter and Mars, and stars are pinpoint images. Under poor seeing conditions, images are blurred and stars appear as blobs. Seeing conditions are rated on a five-point scale where one is the worst and five is the best (see figure 6-5). Seeing conditions can be classified in one of three categories.

Type 1 seeing conditions are characterized by rapid changes in the image seen through the telescope. Extended objects, like the Moon, appear to shimmer while point sources (i.e., stars) appear double. Type 1 seeing is caused by currents within or very close to the telescope tube. These currents could be caused by a telescope that has not reached thermal equilibrium with the outdoor surroundings, heat waves from people standing near the telescope, or heated dew caps. To avoid the problems associated with Type 1 seeing, allow your telescope at least 45 minutes to reach thermal equilibrium. Once adjusted to the outdoor temperature, don't touch the telescope tube with your hands. If observing with others, make sure no one stands in front of or directly below the telescope tube.

Type 2 seeing conditions do move as quickly as Type 1, though the image is quite blurry. Fine detail is lost and the contrast is low for extended objects. Stars are spread out and not sharp. The source of Type 2 seeing is the lower atmosphere, most likely heat waves from the ground or buildings. To avoid the problems associated with Type 2 seeing, select a good observing site. Specifically, avoid sites that overlook asphalt parking lots or ploughed fields. Stay away from valleys and shorelines. Look for broad hill tops or open grassy fields. Stable thermal conditions found near lakes and atmospheric inversions also tend to produce good seeing. If you can't get a better location, wait until the early morning hours when the surroundings are uniformly cool and the seeing is generally better.

Type 3 seeing conditions are characterized by fast ripples, but sharp images. In extended objects fine detail is visible, but the image shifts around the field. Stars are crisp points, but they shift small distances rapidly around the field. The cause of type 3 seeing is turbulence in the upper atmosphere which means the observer has less control over it. However, the effects of Type 3 seeing are generally less pronounced that the other two types. You can never really avoid Type 3 seeing. Your best bet is to wait until moments of steadiness. If the seeing is extremely bad, pack up and wait for a better night.

The conditions described here apply to both visual and photographic observations.

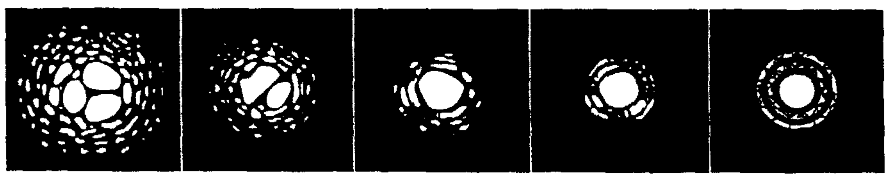


Figure 6-5

Seeing conditions directly affect image quality. These drawings represent a point source (i.e., star) under bad seeing conditions (left) to excellent conditions (right). Most often, seeing conditions produce images that lie some where between these two extremes.

CELESTIAL PHOTOGRAPHY

After looking at the night sky for awhile you may want to try photographing it. Several forms of celestial photography are possible with your Celestron CG-11 telescope. The most common forms of celestial photography, in order of difficulty are; short exposure prime focus, piggyback, eyepiece projection, and long exposure deep sky. Each of these is discussed in moderate detail with enough information to get you started. Topics include the accessories required and some simple techniques. More information is available in some of the publications listed at the end of this manual.

In addition to the specific accessories required for each type of celestial photography, there is the need for a camera — but not just any camera. The camera does not need many of the features offered on today's state-of-the-art equipment. For example, you don't need auto focus capability or mirror lock up. Here are the mandatory features a camera needs for celestial photography. First, a 'B' setting which allows for time exposures. This excludes point and shoot cameras and limits the selection to SLR cameras, the most common type of 35mm camera on the market today.

Second, the 'B' or manual setting should not run off the battery. Many new electronic cameras use the battery to keep the shutter open during time exposures. Once the batteries are drained, usually after a few minutes, the shutter closes, whether you were finished with the exposure or not. Look for a camera that has a manual shutter when operating in the time exposure mode. Olympus, Nikon, Minolta, Pentax and others have made such camera bodies.

The camera should have interchangeable lenses so you can attach it to the telescope and so you can use a variety of lenses for piggyback photography. If you can't find a new camera, you can purchase a used camera body that is not 100-percent functional. The light meter does not have to be operational since you will be determining the exposure length manually.

A Cable release is needed with a locking function to hold the shutter open while you do other things. Mechanical and air releases are available.

Is unguided astrophotography possible? Yes and no. For solar (filtered), lunar, and piggyback (up to 200mm telephotos), the answer is yes. However, even with PEC, off-axis guiding is still mandatory for long exposure, deep sky astrophotography. The Reducer/Corrector lens reduces exposure times making the task of guiding a little easier.

Short Exposure Prime Focus

Short exposure prime focus photography is the best way to begin recording celestial objects. It is done with the camera attached to the telescope without an eyepiece or camera lens in place. To attach your camera you need the Celestron T-Adapter (#93633) and a T-Ring for your specific camera (i.e., Minolta, Nikon, Pentax, etc.). The T-Ring replaces the 35mm SLR camera's normal lens. Prime focus photography allows you to capture the majority of the solar disk (if using the proper filter) as well as the Moon. To attach your camera to your CG-11:

1. Remove all visual accessories.
2. Thread the T-Ring onto the T-Adapter.
3. Mount your camera body onto the T-Ring the same as you would any other lens.
4. Thread the T-Adapter onto the back of the Celestron CG-11 while holding the camera in the desired orientation (either vertical or horizontal).

With your camera attached to the telescope, you are ready for prime focus photography. Start with an easy object like the Moon. Here's how to do it:

1. Load your camera with film that has a moderate-to-fast speed (i.e., ISO rating). Faster films are more desirable when the Moon is a crescent. When the Moon is near full, and at its brightest, slower films are more desirable. Here are some film recommendations:
    - T-Max 100
    - T-Max 400
    - Any 100 to 400 ISO color slide film
    - Fuji Super HG 400
2. Center the Moon in the field of your CG-11.
3. Focus the telescope by turning the focus knob until the image is sharp.
4. Set the shutter speed to the appropriate setting (see the table below).
5. Trip the shutter using a cable release.
6. Advance the film and repeat the process.

Lunar Phase	ISO 50	ISO 100	ISO 200	ISO 400
Crescent	1/2	1/4	1/8	1/15
Quarter	1/15	1/30	1/60	1/125
Full	1/30	1/60	1/125	1/125

Table 7-1

Above is a listing of recommended exposure times when photographing the Moon at the prime focus of your Celestron CG-11 telescope.

The exposure times listed here should be used as a starting point. Always make exposures that are longer and shorter than the recommended time. Also, try bracketing your exposures, taking a few photos at each shutter speed. This will ensure that you will get a good photo.

Keep accurate records of your exposures. This information is useful if you want to repeat your results or if you want to submit some of your photos to various astronomy magazines for possible publication!

This same technique is used for photographing the Sun with the proper Celestron solar filter.

Piggyback

The easiest way to enter the realm of deep-sky, long exposure astrophotography is via the piggyback method. Piggyback photography is done with a camera and its normal lens riding on top of the telescope. Through piggyback photography you can capture entire constellations and record large scale nebulae that are too big for prime focus photography. Because you are photographing with a low power lens and guiding with a high power telescope, the margin for error is very large. Small mistakes made while guiding the telescope will not show up on film. To attach the camera to the telescope, use the optional piggyback mount (#93600), which attaches to a bar that runs the length of the telescope tube (See the instruction sheet that accompanies this product for installation instructions).

As with any form of deep-sky photography, you must be at a dark sky observing site. Light pollution around major urban areas washes out the faint light of deep-sky objects.

1. Polar align the telescope (using one of the methods described earlier) and start the clock drive.
2. Load your camera with slide film, ISO 100 or faster, or print film, ISO 400 or faster!
3. Set the f/ratio of your camera lens so that it is a half stop to one full stop down from completely open.
4. Set the shutter speed to the "B" setting and focus lens to infinity setting.
5. Locate the area of the sky that you want to photograph and move the telescope so that it points in that direction.
6. Find a suitable guide star in the telescope field. This is relatively easy since you can search a wide area without affecting the area covered by your camera lens. If you do not have an illuminated cross hair eyepiece for guiding, simply defocus your guide star until it fills most of the field of view. This makes it easy to detect any drift.
7. Release the shutter using a cable release.
8. Monitor your guide star for the duration of the exposure. Make all corrections using the hand controller.
9. Close the camera's shutter.

As for lenses, get good ones that produce sharp images near the edge of the field. Generally, stay away from generic lenses. The lenses should have a resolving power of 40 lines per millimeter. A good focal length range is 35 to 100mm for lenses designed for 35mm cameras.

The exposure time depends on the film being used. However, five minutes is usually a good starting point. With slower films, like 100 ISO, you can expose as long as 45 minutes. With faster films, like 1600 ISO, you really shouldn't expose more than 5 to 10 minutes. When getting started, use fast films to record as much detail in the shortest possible time. Here are proven recommendations:

- Ektar 1000 (color print)
- Konica 3200 (color print)
- Fujichrome 1600D (color slide)
- 3M 1000 (color slide)
- T-Max 3200 (black and white print)
- T-Max 400 (black and white print)

As you perfect your technique, try specialized films (i.e., specially designed and/or treated) for this type of astrophotography. Here are some popular choices:

- Ektar 125 (color print)
- Fujichrome 100D (color slide)
- Tech Pan, gas hypered (black and white print)
- T-Max 400 (black and white print)

As with all forms of photography, keep accurate records of your work. This information can be used later if you want to reproduce certain results or if you want to submit photos for possible publication.

Once you have mastered piggyback photography with wide angle and normal lenses, try longer focal length lenses. The longer the focal length, the more accurate your guiding must be. You can continue to increase the focal length of the lens until you are ready for prime focus photography with your Celestron CG-11.

Eyepiece Projection

This form of celestial photography is designed for objects with small angular sizes, primarily the Moon and planets. Planets, although physically quite large, appear small in angular size because of their great distances. Moderate to high magnification is, therefore, required to make the image large enough to see any detail. Unfortunately, the camera/telescope combination alone does not provide enough magnification to produce a usable image size on film. In order to get the image large enough, you must attach your camera to the telescope with the eyepiece in place. To do so, you need two additional accessories; a tele-extender (#93643), which attaches onto the visual back, and a T-ring for your particular camera make (i.e., Minolta, Nikon, Pentax, etc.).

Because of the high magnifications during eyepiece projection, the field of view is quite small which makes it difficult to find and center objects. To make the job a little easier, align the finder as accurately as possible. This allows you to get the object in the field based on the finder view alone.

Another problem introduced by the high magnification is vibration. Simply tripping the shutter — even with a cable release — produces enough vibration to smear the image. To get around this, use the camera's self-timer if the exposure time is less than one second — a common occurrence when photographing the Moon. For exposures over one second, use the "hat trick." This technique incorporates a hand-held black card placed over the aperture of the telescope to act as a shutter. The card prevents light from entering the telescope while the shutter is released. Once the shutter has been released and the vibration has diminished (a few seconds), move the black card out of the way to expose the film. After the exposure is complete, place the card over the front of the telescope and close the shutter. Advance the film and you're ready for your next shot. Keep in mind that the card should be held a few inches in front of the telescope, and not touching it. It is easier if you use two people for this process; one to release the camera shutter and one to hold the card. Here's the process for making the exposure.

1. Find and center the desired target in the view finder of your camera.
2. Turn the focus knob until the image is as sharp as possible.
3. Place the black card over the front of the telescope.
4. Release the shutter using a cable release.
5. Wait for the vibration caused by releasing the shutter to diminish. Also, wait for a moment of good seeing.
6. Remove the black card from in front of the telescope for the duration of the exposure (see accompanying table).
7. Replace the black card over the front of the telescope.
8. Close the camera's shutter.

Advance the film and your ready for your next exposure. Don't forget to take photos of varying duration and keep accurate records of what you have done. Record the date, telescope, exposure duration, eyepiece, f/ratio, film, and some comments on the seeing conditions.

The following table lists exposures for eyepiece projection with a 10mm eyepiece. All exposure times are listed in seconds or fractions of a second.

Planet	ISO 50	ISO 100	ISO 200	ISO 400
Moon	4	2	1	1/2
Mercury	16	8	4	2
Venus	1/2	1/4	1/8	1/15
Mars	16	8	4	2
Jupiter	8	4	2	1
Saturn	16	8	4	2

Table 7-2

The exposure times listed here should be used as a starting point. Always make exposures that are longer and shorter than the recommended time. Also, try bracketing your exposures, taking a few photos at each shutter speed. This will ensure that you will get a good photo. It is not uncommon to go through an entire roll of 36 exposures and have only one shot turn out good.

Don't expect to record more detail than you can see visually in the eyepiece at the time you are photographing.

Once you have mastered the technique, experiment with different films, different focal length eyepieces, and even different filters.

Long Exposure Prime Focus

This is the last form of celestial photography to be attempted after others have been mastered. It is intended primarily for deep sky objects, that is objects outside our solar system which includes star clusters, nebulae, and galaxies. While it may seem that high magnification is required for these objects, just the opposite is true. Most of these objects cover large angular areas and fit nicely into the prime focus field of your Celestron CG-11 telescope. The brightness of these objects, however, requires long exposure times and, as a result, are rather difficult.

There are several techniques for this type of photography, and the one chosen will determine the standard accessories needed. If, for example, you use a separate guidescope, the camera attaches to the telescope with a T-Adapter (#93633) and a T-Ring for your specific camera. However, the best method for long exposure deep sky astrophotography is with an off-axis guider. This devise allows you to photograph through the telescope and guide simultaneously. Celestron offers a very special and advanced off-axis guider, called the Radial Guider (#94176). In addition, you will need a T-Ring to attach your camera to the Radial Guider.

Other equipment needs include a guiding eyepiece. Unlike piggyback photography which allows for fairly loose guiding, prime focus requires meticulous guiding for long periods. To accomplish this you need a guiding ocular with an illuminated reticle to monitor your guide star. For this purpose, Celestron offers the Micro Guide Eyepiece (#94171). Here is a brief summary of the technique.

1. Polar align the telescope using the declination drift method.
2. Remove all visual accessories.
3. Thread the Radial Guider onto your Celestron CG-11.
4. Thread the T-Ring onto the Radial Guider.
5. Mount your camera body onto the T-Ring the same as you would any other lens.
6. Set the shutter speed to the "B" setting.
7. Focus the telescope on a star using a focusing aid such as the Celestron MFFT-55.
8. Center your subject in the field of your camera.
9. Find a suitable guide star in the telescope field. This can be the most time consuming process.
10. Open the shutter using a cable release.
11. Monitor your guide star for the duration of the exposure.
12. Close the camera's shutter.

When getting started, use fast films to record as much detail in the shortest possible time. Here are proven recommendations:

- Ektar 1000 (color print)
- Konica 3200 (color print)
- Fujichrome 1600D (color slide)
- 3M 1000 (color slide)
- T-Max 3200 (black and white print)
- T-Max 400 (black and white print)

As you perfect your technique, try specialized films (i.e., specially designed and/or treated) for this type of astrophotography. Here are some popular choices:

- Ektar 125 (color print)
- Fujichrome 100D (color slide)
- Tech Pan, gas hypered (black and white print)
- T-Max 400 (black and white print)

There is no exposure determination table to help you get started. The best way to determine exposure length is look at previously published photos to see what film/exposure combination was used. Or take unguided sample photos of various parts of the sky while the drive is running. Take exposures of various lengths to determine the best exposure time.

TELESCOPE MAINTENANCE

While your CG-11 telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs at its best.

Care and Cleaning of the Optics

Occasionally, dust and/or moisture may build up on the corrector plate of your telescope. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust has built up on the corrector plate, remove it with a brush (made of camel's hair) or a can of pressurized air. Spray at an angle to the lens for approximately two to four seconds. Then, use an optical cleaning solution and white tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the lens. Low pressure strokes should go from the center of the corrector to the outer portion. **Do NOT rub in circles!**

You can use a commercially made lens cleaner or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

Occasionally, you may experience dew build-up on the corrector plate of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer or by pointing the telescope at the ground until the dew has evaporated.

If moisture condenses on the inside of the corrector, remove the accessories from the rear cell of the telescope. Place the telescope in a dust-free environment and point it down. This will remove the moisture from the telescope tube.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the rear cell is NOT sealed, the cover should be placed over the opening when not in use. This will prevent contaminants from entering the optical tube.

Internal adjustments and cleaning should be done only by the Celestron repair department. If your telescope is in need of internal cleaning, please call the factory for a return authorization number and price quote.

Collimation

The optical performance of your Celestron CG-11 telescope is directly related to its collimation, that is the alignment of its optical system. Your Celestron CG-11 was collimated at the factory after it was completely assembled. However, if the telescope is dropped or jarred severely during transport, it may have to be collimated. The only optical element that may need to be adjusted, or is possible, is the tilt of the secondary mirror.

To check the collimation of your telescope you will need a light source. A bright star near the zenith is ideal since there is a minimal amount of atmospheric distortion. Turn your telescope drive on so that you won't have to manually track the star. Or, if your are not using the clock drive, use Polaris. Its position relative to the celestial pole means that it moves very little thus eliminating the need to manually track it.

Before you begin the collimation process, be sure that your telescope is in thermal equilibrium with the surroundings. Allow 45 minutes for the telescope to reach equilibrium if you move it between large temperature extremes.

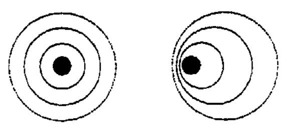


Figure 8-1

In focus images show the CG-11 in collimation (left) and out of collimation (right).

To verify collimation, view a star near the zenith. Use a medium to high power ocular — 12mm to 6mm focal length. It is important to center a star in the center of the field to judge collimation. Slowly cross in and out of focus and judge the symmetry of the star. If you see a systematic skewing of the star to one side, then recollimation is needed.

To accomplish this, you need to tighten the secondary collimation screw(s) that move the star across the field toward the direction of the skewed light. These screws are located in the secondary mirror holder. Make only a small 1/6 to 1/8 field correction and recenter the star by moving the scope before making any improvements or before making further adjustments.

When using higher power, 6mm and above, collimation is best accomplished with the telescope in focus. In this instance, you are observing the Airy disk (see figure 8-1), not the shadow of the secondary housing. This (stellar) image will appear as a bright point of light with a diffraction ring around it. When the point of light is perfectly centered within the diffraction ring, your telescope is in collimation. Keep in mind that to use high power, the seeing conditions must be very good.

Perfect collimation will yield a star or planetary image very symmetrical just inside and outside of focus. In addition, perfect collimation delivers the optimal optical performance specifications that your telescope is built to achieve.

If seeing (i.e., air steadiness) is turbulent, collimation is difficult to judge. Wait until a better night if it is turbulent or aim to a steadier part of the sky. A steadier part of the sky is judged by steady versus twinkling stars.

NOTE: **THE ADJUSTMENT SCREWS ON THE SECONDARY MIRROR ARE VERY SENSITIVE. USUALLY A TENTH OF A TURN WILL COMPLETELY CHANGE THE COLLIMATION OF THE TELESCOPE. DO NOT FORCE THESE SCREWS IF THEY WILL NOT TURN. IF TIGHTENING ONE SCREW IN THE DIRECTION YOU NEED TO GO IS DIFFICULT, SIMPLY LOOSEN THE OTHER TWO SCREWS BY EQUAL AMOUNTS TO BRING ABOUT THE SAME CHANGE. DO NOT BE INTIMIDATED TO TOUCH UP COLLIMATION AS NEEDED TO ACHIEVE OPTIMAL HIGH-RESOLUTION VIEWS. IT IS WORTH THE TROUBLE!!!!**

OPTIONAL ACCESSORIES

The following is a partial list of optional accessories available for your Celestron CG-11. You will find that additional accessories enhance your viewing pleasure and expand the usefulness of your telescope. For ease of reference, all the accessories are listed in alphabetical order.

AC Adapter (#18770) - To power your telescope from 110 volt 60Hz power source. Distributors requiring 220v - 50 Hz should buy Model #18770-230V.

Accessory Case (#93500) - This rugged ABS plastic case is designed for carrying a few accessories. Inside is foam padding that is die cut to 1x1 inch squares. These squares can be removed to accommodate accessories and eyepieces with a custom fit.

Advanced Astro Master (#93900) - Imagine observing hundreds of deep-sky objects in one night. **With the Advanced Astro Master you don't have to imagine!** This unique accessory contains a data base of more than 10,000 objects! Included are the Messier catalog, NGC catalog, IC catalog, portions of the ESO catalog, portions of the UGC catalog, special non-stellar catalog which contains objects not found in any of the other catalogs, a star catalog containing 241 interesting double and multiple stars, a user definable catalog that allows you to enter 25 of your favorite objects. And, scrolling information cross references *Sky Atlas 2000.0* or *Uranometria*. Unlike other digital setting circles, which require the use of a clock drive, the Advanced Astro Master can be used with or without a clock drive. All you have to do is align on any two of the 28 alignment stars in the Advanced Astro Master's data base and you are ready to observe. Once aligned, the system keeps track of where it is pointed. And, the Advanced Astro Master now has an RS-232 port for complete interface to your personal computer. The RS-232 cable (#93921) is currently available and ready for shipment. The hardware mounting kit for the CG-11 is #93915.

Barlow Lens - A Barlow lens is a negative lens that increases the focal length of a telescope. Used with any eyepiece, it doubles the magnification of that eyepiece. Celestron offers two Barlow lens in the 1-1/4" size for the CG-11. The 2x Ultima Barlow (#93506) is a compact triplet design that is multicoated for maximum light transmission and parfocal when used with the Ultima eyepieces. It works very well with all Celestron eyepieces. The latest Barlow to be added to Celestron's product line (#93507) is a low profile achromatic design that is fully coated. It weighs just 4 oz. and it is under 3" in length.

Counterweight, Extra - As you know, the CG-11 comes standard with one 22 pound counterweight (the CG-14 has additional counterweights) which is adequate to balance the telescope with the standard accessories. If heavier equipment is added to the mount, you will need an extra counterweight (#94195). The extra counterweight weighs approximately 11 pounds making balance of the telescope a breeze with just about any equipment attached.

Eyepiece Types - Like telescopes, eyepieces come in a variety of designs. Each different design has its own advantages and disadvantages. For the 1-1/4" barrel diameter there are three different eyepiece designs available.

- **Plössl** - Plössl eyepieces have a 4-element lens designed for low-to-high power observing. The Plössls offer razor sharp views across the entire field, even at the edges! In the 1-1/4" barrel diameter, they are available in the following focal lengths: 7.5mm, 10mm, 17mm, 26mm, and 40mm.

- **Ultima** - is not really a design, but a trade name for our 5-element, wide field eyepieces. In the 1-1/4" barrel diameter, they are available in the following focal lengths: 5mm, 7.5mm, 12.5mm, 18mm, 24mm, 30mm, 35mm, and 42mm. The 35mm Ultima gives the widest possible field of view with a 1-1/4" diagonal and is ideal for the CG-11. In the 2" barrel diameter, there are three focal lengths: 45mm, 60mm, and 80mm.

- **Lanthanum Eyepieces (LV Series)** - Lanthanum is a unique rare earth glass used in one of the field lenses of this new eyepiece. The Lanthanum glass reduces aberrations to a minimum. All are fully multicoated and have an astounding 20mm of eye relief — perfect for eyeglass wearers! In the 1-1/4" barrel diameter, they are available in the following focal lengths: 2.5mm, 4mm, 5mm, 6mm, 9mm, 10mm, 15mm, 20mm, and 25mm. In the 2" barrel diameter, there is a 30mm.

In addition to the previously mentioned, there is also a deluxe compact zoom ocular (#93306) that has a variable focal length of 6.5 to 18mm. This provides 155 to 430 power on the CG-11.

Eyepiece Filters - To enhance your visual observations of solar system objects, Celestron offers a wide range of colored filters that thread into the 1-1/4" oculars. Available are: #1A skylight, #8 yellow, #12 deep yellow, #15 deep yellow, #21 orange, #23A light red, #25 red, #38A blue, #47 violet, #56 light green, #58 green, #80A light blue, #82A pale blue, #96 neutral density - 50%T, #96 neutral density - 25%T, #96 neutral density - 13%T, and polarizing. The filters are sold separately so you can buy them individually as you need them!

Finder Illuminator and Polaris Guiding Plate - The 7x50 finder that comes standard with the CG-11 contains a polar alignment reticle designed exlusively for polar alignment. However, there is no light source to illuminate the reticle. To solve this problem, you will need the Finder Illuminator (#51614-IL). And, to locate the proper position of Polaris relative to the celestial pole you will need the Polaris Setting Plate (#60121). Both these working together will give you a quick and accurate polar alignment.

Finder Bracket, Quick Release (#51149-A) - This unique bracket allows you to attach 50mm finders to C11 telescopes. No tools are required to attach or remove the finder, and once aligned, it keeps the alignment.

Flashlight (#93592) - The LED flashlight uses a red LED to allow reading star maps without ruining your night vision. The LED flashlight is small, only 6 inches long, and weighs in at a mere 3 ounces.

Light Pollution Rejection (LPR) Filters - These filters are designed to enhance your views of deep sky astronomical objects when viewed from urban areas. LPR Filters selectively reduce the transmission of certain wavelengths of light, specifically those produced by artificial lights. This includes mercury and high and low pressure sodium vapor lights. In addition, they also block unwanted natural light (sky glow) caused by neutral oxygen emission in our atmosphere. Celestron offers a model for 1-1/4" eyepieces (#94126A), a model that attaches to the rear cell ahead of the star diagonal and visual back (#94127A), and one attaches to the back of the radial guider (#94129) This last model allows you to guide on an unfiltered star while the light from your subject passes through the filter to a camera.

Micro Guide Eyepiece (#94171) - This multipurpose illuminated 12.5mm reticle can be used for guiding deep-sky astrophotos, measuring position angles, angular separations, and more. The laser etched reticle provides razor sharp lines and the variable brightness illuminator is completely cordless. The micro guide eyepiece produces 224 power when used with the CG-11 at f/10.

Polarizing Filter Set (#93608) - The polarizing filter assembly limits the transmission of light to a specific plane, thus increasing contrast between various objects. This is used primarily for terrestrial, lunar and planetary observing.

Radial Guider (#94176) - The Celestron® Radial Guider is specifically designed for use in prime focus, deep sky astrophotography and takes the place of the T-Adapter. This device allows you to simultaneously photograph and guide through the optical tube assembly of your telescope. This type of guiding produces the best results since what you see through the guiding eyepiece is exactly reproduced on the processed film. The Radial Guider is a "T"-shaped assembly that attaches to the rear cell of the telescope. As light from the telescope enters the guider, most passes straight through to the camera. A small portion, however, is diverted by a prism at a right angle up to the guiding eyepiece. This guider has two features not found on other off-axis guiders; first, the prism and eyepiece housing rotate independently of camera orientation making the acquisition of a guide star quite easy. Second, the prism angle is tunable allowing you to look at guide stars on-axis. This accessory works especially well with the Reducer/ Corrector Lens.

Reducer/Corrector Lens (#94175) - This lens reduces the focal length of the telescope by 37%, making your CG-11 a 1764mm f/6.3 (CG-14 a 2463mm f/7) instrument. In addition, this unique lens also corrects inherent aberrations to produce crisp images all the way across the field. It also increases the field of view significantly and is ideal for wide-field, deep-space viewing. It is also perfect for beginning prime focus, long-exposure astrophotography. It makes guiding easier and exposures shorter.

Skylight Filter (#93621) - The Skylight filter is used on the Celestron CG-11 telescope as a dust seal. The filter threads onto the reducer plate on the rear cell of your telescope. All other accessories, both visual and photographic (with the exception of Barlow lenses), thread onto the skylight filter. The light loss caused by this filter is minimal.

Sky Maps (#93722) - When learning the night sky, the Celestron sky maps offer the ideal solution. The maps include all the constellations and brighter deep-sky objects. The maps are printed on a heavy stock paper that is moisture resistant. On the front cover is a rotating planisphere which indicates when specific constellations are visible.

Solar Filter - Celestron Solar Skreen® solar filters permit direct observation of the Sun in complete safety. These filters, which transmit .001% of visible light, allow you to see sunspots as they move across the solar disk. In addition to reducing the intensity of the Sun's visible light, they also block 99.999% of invisible infrared light. The Celestron Solar Skreen® solar filters are made of precision engineered Mylar polyester film. A layer of aluminum is vacuum-deposited on one surface of the dual sheets of Mylar used to make each filter. The aluminum coating produces a cool, comfortable pale blue image of the Sun. (A #21 orange eyepiece filters works well in conjunction with these filters to produce a more natural colored Sun.) These filters can be used for visual observation and photography. Celestron offers a 5" off-axis filter (#94163) for the Celestron CG-11 and an 8" off axis filter (#94164) for the CG-14.

NOTE: **NEVER LOOK DIRECTLY AT THE SUN WITH THE NAKED EYE OR WITH A TELESCOPE. NEVER POINT YOUR TELESCOPE AT THE SUN UNLESS YOU HAVE THE PROPER FILTER.**

Star Diagonal (#93519) - Like the 1-1/4" Star Diagonal, the 2" Star Diagonal allows you to view at a right angle to the telescope's main optical tube. The right angle viewing position is ideal for looking at objects that are overhead or generally a great distance from the horizon. As an optional accessory (standard with the CG-14), Celestron offers a 2" Star Diagonal to be used with a 2" eyepiece. 2" eyepieces offer wider fields and better eye relief.

T-Adapter (#93633-A) - A T-Adapter (with T-Ring) allows you to attach your camera to the prime focus of the Celestron CG-11. This is used for terrestrial photography and short exposure lunar photography. It can be used for long exposure deep space photography if using a separate guide scope.

T-Ring - The T-Ring couples your camera body to the T-Adapter, radial guider, or tele-extender. This accessory is mandatory if you want to do astrophotography through the telescope. Each camera make (i.e., Minolta, Nikon, Pentax, etc.) has its own unique mount and therefore, its own T-Ring. Celestron has 10 different models for 35mm cameras.

Tele-Extender, Deluxe (#93643) - The tele-extender is a hollow tube that allows you to attach a camera to the telescope when the eyepiece is installed. This accessory is used for eyepiece projection photography which allows you to capture very high power views of the Sun, Moon, and planets on film. The tele-extender fits over the eyepiece onto the visual back. This tele-extender works with eyepieces that have large housings, like the Celestron Ultima series.

A full description of all Celestron accessories can be found in the Celestron accessory catalog (#93685).

THE MESSIER CATALOG

The Messier Catalog, compiled by Charles Messier, was the first extensive listing of star clusters and nebulae. Messier's primary observational purpose was to discover comets. He compiled this list so that others searching for comets would not be confused by these objects. His list still remains popular today because all of these objects are easily visible in amateur telescopes.

M#	NGC#	Const.	R.A. H M S	DEC ° ′	Mag	Type	Proper Name
M1	NGC 1952	Tau	5 34.5	22 01	8.4	P. Neb.	Crab Nebula
M2	NGC 7089	Aqr	21 33.5	-00 49	6.5	Gl. Cl.	
M3	NGC 5272	CVn	13 42.2	28 23	6.4	Gl. Cl.	
M4	NGC 6121	Sco	16 23.6	-26 32	5.9	Gl. Cl.	
M5	NGC 5904	Ser	15 18.5	2 05	5.8	Gl. Cl.	
M6	NGC 6405	Sco	17 40.0	-32 13	4.2	Op. Cl.	Butterfly Cluster
M7	NGC 6475	Sco	17 54.0	-34 49	3.3	Op. Cl.	
M8	NGC 6523	Sgr	18 03.7	-24 23	5.8	D. Neb.	Lagoon Nebula
M9	NGC 6333	Oph	17 19.2	-18 31	7.9	Gl. Cl.	
M10	NGC 6254	Oph	16 57.2	-4 06	6.6	Gl. Cl.	
M11	NGC 6705	Sct	18 51.1	-6 16	5.8	Op. Cl.	Wild Duck Cluster
M12	NGC 6218	Oph	16 47.2	-1 57	6.6	Gl. Cl.	
M13	NGC 6205	Her	16 41.7	36 28	5.9	Gl. Cl.	Hercules Cluster
M14	NGC 6402	Oph	17 37.6	-3 15	7.6	Gl. Cl.	
M15	NGC 7078	Peg	21 30.0	12 10	6.4	Gl. Cl.	
M16	NGC 6611	Ser	18 18.9	-13 47	6.0	D. Neb.	Eagle Nebula
M17	NGC 6618	Sgr	18 20.8	-16 11	7.0	D. Neb.	Omega Nebula
M18	NGC 6613	Sgr	18 19.9	-17 08	6.9	Op. Cl.	
M19	NGC 6273	Oph	17 02.6	-26 16	7.2	Gl. Cl.	
M20	NGC 6514	Sgr	18 02.4	-23 02	8.5	D. Neb.	Trifid Nebula
M21	NGC 6531	Sgr	18 04.7	-22 30	5.9	Op. Cl.	
M22	NGC 6656	Sgr	18 36.4	-23 54	5.1	Gl. Cl.	
M23	NGC 6494	Sgr	17 56.9	-19 01	5.5	Op. Cl.	
M24	NGC 6603	Sgr	18 16.4	-18 29	4.5	Op. Cl.	
M25	IC 4725	Sgr	18 31.7	-19 15	4.6	Op. Cl.	
M26	NGC 6694	Sct	18 45.2	-9 24	8.0	Op. Cl.	
M27	NGC 6853	Vul	19 59.6	22 43	8.1	P. Neb.	Dumbbell Nebula
M28	NGC 6626	Sgr	18 24.6	-24 52	6.9	Gl. Cl.	
M29	NGC 6913	Cyg	20 23.0	38 32	6.6	Op. Cl.	
M30	NGC 7099	Cap	21 40.4	-23 11	7.5	Gl. Cl.	
M31	NGC 224	And	0 42.7	41 16	3.4	Sp. Gx.	Andromeda Galaxy
M32	NGC 221	And	0 42.7	40 52	8.2	El. Gx.	
M33	NGC 598	Tri	1 33.8	30 39	5.7	Sp. Gx.	Pinwheel Galaxy
M34	NGC 1039	Per	2 42.0	42 47	5.2	Op. Cl.	
M35	NGC 2168	Gem	6 08.8	24 20	5.1	Op. Cl.	

M#	NGC#	Const.	R.A. H M S	DEC ° ′	Mag	Type	Proper Name
M36	NGC 1960	Aur	5 36.3	34 08	6.0	Op. Cl.	
M37	NGC 2099	Aur	5 52.0	32 33	5.6	Op. Cl.	
M38	NGC 1912	Aur	5 28.7	35 50	6.4	Op. Cl.	
M39	NGC 7092	Cyg	21 32.3	48 26	4.6	Op. Cl.	
M40		UMa	12 22.2	58 05	8.0	dbl	
M41	NGC 2287	CMa	6 47.0	-20 44	4.5	Op. Cl.	
M42	NGC 1976	Ori	5 35.3	-5 27	4.0	D. Neb.	Great Orion Nebula
M43	NGC 1982	Ori	5 35.5	-5 16	9.0	D. Neb.	
M44	NGC 2632	Cnc	8 40.0	19 59	3.1	Op. Cl.	Beehive Cluster
M45		Tau	3 47.5	24 07	1.2	Op. Cl.	Pleiades
M46	NGC 2437	Pup	7 41.8	-14 49	6.1	Op. Cl.	
M47	NGC 2422	Pup	7 36.6	-14 30	4.4	Op. Cl.	
M48	NGC 2548	Hya	8 13.8	-5 48	5.8	Op. Cl.	
M49	NGC 4472	Vir	12 29.8	8 00	8.4	El. Gx.	
M50	NGC 2323	Mon	7 03.0	-8 20	5.9	Op. Cl.	
M51	NGC 5194-5	CVn	13 29.9	47 12	8.1	Sp. Gx.	Whirlpool Galaxy
M52	NGC 7654	Cas	23 24.2	61 35	6.9	Op. Gx.	
M53	NGC 5024	Com	13 12.9	18 10	7.7	Gl. Cl.	
M54	NGC 6715	Sgr	18 55.1	-30 29	7.7	Gl. Cl.	
M55	NGC 6809	Sgr	19 40 .0	-30 58	7.0	Gl. Cl.	
M56	NGC 6779	Lyr	19 16.6	30 11	8.2	Gl. Cl.	
M57	NGC 6720	Lyr	18 53.6	33 02	9.0	P. Neb.	Ring Nebula
M58	NGC 4579	Vir	12 37.7	11 49	9.8	Sp. Gx.	
M59	NGC 4621	Vir	12 42.0	11 39	9.8	El. Gx.	
M60	NGC 4649	Vir	12 43.7	11 33	8.8	El. Gx.	
M61	NGC 4303	Vir	12 21.9	4 28	9.7	Sp. Gx.	
M62	NGC 6266	Oph	17 01.2	-30 07	6.6	Gl. Cl.	
M63	NGC 5055	CVn	13 15.8	42 02	8.6	Sp. Gx.	Sunflower Galaxy
M64	NGC 4826	Com	12 56.7	21 41	8.5	Sp. Gx.	Black Eye Galaxy
M65	NGC 3623	Leo	11 18.9	13 05	9.3	Sp. Gx.	Leo's Triplet
M66	NGC 3627	Leo	11 20.3	12 59	9.0	Sp. Gx.	Leo's Triplet
M67	NGC 2682	Cnc	8 50.3	11 49	6.9	Op. Cl.	
M68	NGC 4590	Hya	12 39.5	-26 45	8.2	Gl. Cl.	
M69	NGC 6637	Sgr	18 31.4	-32 21	7.7	Gl. Cl.	
M70	NGC 6681	Sgr	18 43.2	-32 18	8.1	Gl. Cl.	
M71	NGC 6838	Sge	19 53.7	18 47	8.3	Gl. Cl.	
M72	NGC 6981	Aqr	20 53.5	-12 32	9.4	Gl. Cl.	
M73	NGC 6994	Aqr	20 58.0	-12 38		ast	
M74	NGC 628	Psc	1 36.7	15 47	9.2	S	
M75	NGC 6864	Sgr	20 06.1	-21 55	8.6	Gl Cl.	
M76	NGC 650-1	Per	1 42.2	51 34	11.5	P. Neb.	Cork Nebula
M77	NGC 1068	Cet	2 42.7	0 01	8.8	Sp. Gx.	
M78	NGC 2068	Ori	5 46.7	0 03	8.0	D. Neb.	
M79	NGC 1904	Lep	5 24.2	-24 33	8.0	Gl. Cl.	
M80	NGC 6093	Sco	16 17.0	-22 59	7.2	Gl. Cl.	

M#	NGC#	Const.	R.A. H M S	DEC ° ′	Mag	Type	Proper Name
M81	NGC 3031	UMa	9 55.8	69 04	6.8	Sp. Gx.	Bodes Nebula
M82	NGC 3034	UMa	9 56.2	69 41	8.4	Ir. Gx.	
M83	NGC 5236	Hya	13 37.7	-29 52	7.6	Sp. Gx.	
M84	NGC 4374	Vir	12 25.1	12 53	9.3	El. Gx.	
M85	NGC 4382	Com	12 25.4	18 11	9.2	El. Gx.	
M86	NGC 4406	Vir	12 26.2	12 57	9.2	El. Gx.	
M87	NGC 4486	Vir	12 30.8	12 24	8.6	El. Gx.	Virgo A
M88	NGC 4501	Com	12 32.0	14 25	9.5	Sp. Gx.	
M89	NGC 4552	Vir	12 35.7	12 33	9.8	El. Gx.	
M90	NGC 4569	Vir	12 36.8	13 10	9.5	Sp. Gx.	
M91	NGC 4548	Com	12 35.4	14 30	10.2	Sp. Gx.	
M92	NGC 6341	Her	17 17.1	43 08	6.5	Gl. Cl.	
M93	NGC 2447	Pup	7 44.6	-23 52	6.2	Op. Cl.	
M94	NGC 4736	CVn	12 50.9	41 07	8.1	Sp. Gx.	
M95	NGC 3351	Leo	10 44.0	11 42	9.7	Sp. Gx.	
M96	NGC 3368	Leo	10 46.8	11 49	9.2	Sp. Gx.	
M97	NGC 3587	UMa	11 14.9	55 01	11.2	P. Neb.	Owl Nebula
M98	NGC 4192	Com	12 13.8	14 54	10.1	Sp. Gx.	
M99	NGC 4254	Com	12 18.8	14 25	9.8	Sp. Gx.	Pin Wheel Nebula
M100	NGC 4321	Com	12 22.9	15 49	9.4	Sp. Gx.	
M101	NGC 5457	UMa	14 03.2	54 21	7.7	Sp. Gx.	
M102	NGC 5457	UMa	14 03.2	54 21	7.7	dup	
M103	NGC 581	Cas	1 33.1	60 42	7.4	Op. Cl.	
M104	NGC 4594	Vir	12 40.0	-11 37	8.3	Sp. Gx.	Sombrero Galaxy
M105	NGC 3379	Leo	10 47.9	12 35	9.3	El. Gx..	
M106	NGC 4258	CVn	12 19.0	47 18	8.3	Sp. Gx.	
M107	NGC 6171	Oph	16 32.5	-13 03	8.1	Gl. Cl.	
M108	NGC 3556	UMa	11 11.6	55 40	10.0	Sp. Gx.	
M109	NGC 3992	UMa	11 57.7	53 23	9.8	Sp. Gx.	
M110	NGC 205	And	0 40.3	41 41	8.0	El. Gx.	

Object Abbreviations:

- Sp. Gx. ....Spiral Galaxy
- El. Gx. ....Elliptical Galaxy
- Ir. Gx. ....Irregular Galaxy
- Op. Cl. ....Open Cluster
- Gl. Cl. ....Globular Cluster
- D. Neb. ....Diffuse Nebula
- P. Neb. ....Planetary Nebula

NOTE: All coordinates for the objects in the Messier catalog are listed in epoch 2000.00.

LIST OF BRIGHT STARS

The following is a list of bright stars that can be used to align the R.A. setting circle. All coordinates are in epoch 2000.0.

Star Name	Constellation	Epoch 2000.0 R.A. H M S	Epoch 2000.0 DEC ° ' "	Magnitude
Sirius	CMa	06 45 09	-16 42 58	-1.47
Canopus	Car	06 23 57	-52 41 44	-0.72
Arcturus	Boo	14 15 40	+19 10 57	-0.72
Rigel Kent.	Cen	14 39 37	-60 50 02	+0.01
Vega	Lyr	18 36 56	+38 47 01	+0.04
Capella	Aur	05 16 41	+45 59 53	+0.05
Rigel	Ori	05 14 32	-08 12 06	+0.14
Procyon	CMi	07 38 18	+05 13 30	+0.37
Betelgeuse	Ori	05 55 10	+07 24 26	+0.41
Achernar	Eri	01 37 43	-57 14 12	+0.60
Hadar	Cen	14 03 49	-60 22 22	+0.63
Altair	Aqi	19 50 47	+08 52 06	+0.77
Aldebaran	Tau	04 35 55	+16 30 33	+0.86
Spica	Vir	13 25 12	-11 09 41	+0.91
Antares	Sco	16 29 24	-26 25 55	+0.92
Fomalhaut	PsA	22 57 39	-29 37 20	+1.15
Pollux	Gem	07 45 19	+28 01 34	+1.16
Deneb	Cyg	20 41 26	+45 16 49	+1.28
Beta Crucis	Cru	12 47 43	-59 41 19	+1.28
Regulus	Leo	10 08 22	+11 58 02	+1.36

FOR FURTHER READING

The following is a list of astronomy books that will further enhance your understanding of the night sky. The books are broken down by classification for easy reference.

Astronomy Texts

Astronomy Now .... Pasachoff & Kutner
Cambridge Atlas Of Astronomy .... Audouze & Israel
McGraw-Hill Encyclopedia Of Astronomy .... Parker
Astronomy-The Evolving Universe .... Zeilik

Atlases

Atlas Of Deep Sky Splendors .... Vehrenberg
Sky Atlas 2000.0 .... Tirion
Sky Catalog 2000.0 Vol 1 & 2 .... Hirshfeld & Sinnott
Uranometria Vol. 1 & 2 .... Tirion, Rappaport, Lovi
Magnitude 6 Star Atlas .... Dickinson, Costanzo, Chaple
NGC 2000.0 .... Sinnott

General Observational Astronomy

The Cambridge Astronomy Guide .... Liller & Mayer
A Complete Manual Of Amateur Astronomy .... Sherrod
The Guide To Amateur Astronomy .... Newton & Teece

Visual Observation

Observational Astronomy For Amateurs .... Sidgwick
Astronomical Calendar .... Ottewell
Burnham's Celestial Handbook Vols. 1, 2 & 3 .... Burnham
The Planet Jupiter .... Peek
Field Guide To The Stars & Planets .... Menzel & Pasachoff
Observe Comets .... Edberg & Levy

Astrophotography

Skyshooting .... Mayall & Mayall
Astrophotography A Step-by-Step Approach .... Little
Astrophotography For The Amateur .... Covington
Astrophotography .... Gordon
Astrophotography II .... Martinez
A Manual Of Celestial Photography .... King
Manual Of Advanced Celestial Photography .... Wallis & Provin
Colours Of The Stars .... Malin & Muirden

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