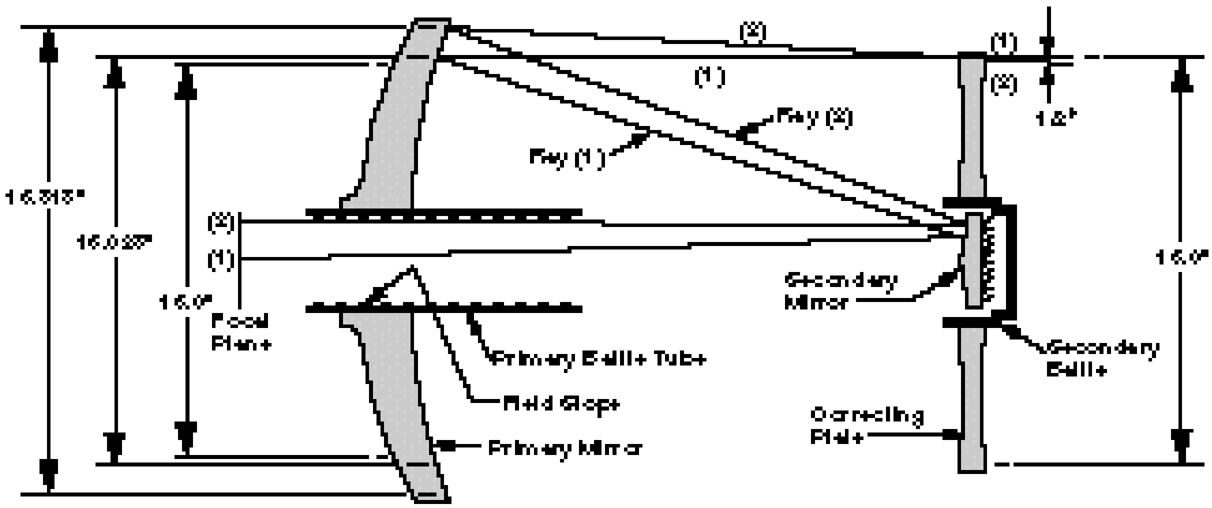
Instruction Manual

16” LX200 Schmidt-Cassegrain Telescope

Meade Instruments Corporation

NOTE: Instructions for the use of optional accessories are not included in this manual. For details see the Meade General Catalog.



The Meade Schmidt-Cassegrain Optical System (Diagram not to scale)

In the Schmidt-Cassegrain design of the Meade 16” model, light enters from the right, passes through a thin lens (correcting plate) with two-sided aspheric correction, proceeds to a spherical primary mirror, and then to a convex aspheric secondary mirror. The convex secondary mirror multiplies the effective focal length of the primary mirror and results in a focus at the focal plane, with light passing through a central perforation in the primary mirror.

The 16” model includes an oversize 16.375” primary mirror, yielding a fully illuminated field-of-view significantly wider than is possible with standard-size primary mirrors. Note that light ray (2) in the figure would be lost entirely, except for the oversize primary. This phenomenon results in Meade 16” Schmidt-Cassegrains having off-axis field illuminations 10% greater, aperture-for-aperture, than other Schmidt-Cassegrains utilizing standard-size primary mirrors.

WARNING!

Never use the LX200 telescope to look at the Sun! Looking at or near the Sun will cause *instant* and *irreversible* damage to your eye. Eye damage is often painless, so there is no warning to the observer that damage has occurred until it is too late. Do not point the telescope or its viewfinder at or near the Sun. Do not look through the telescope or its viewfinder as it is moving. Children

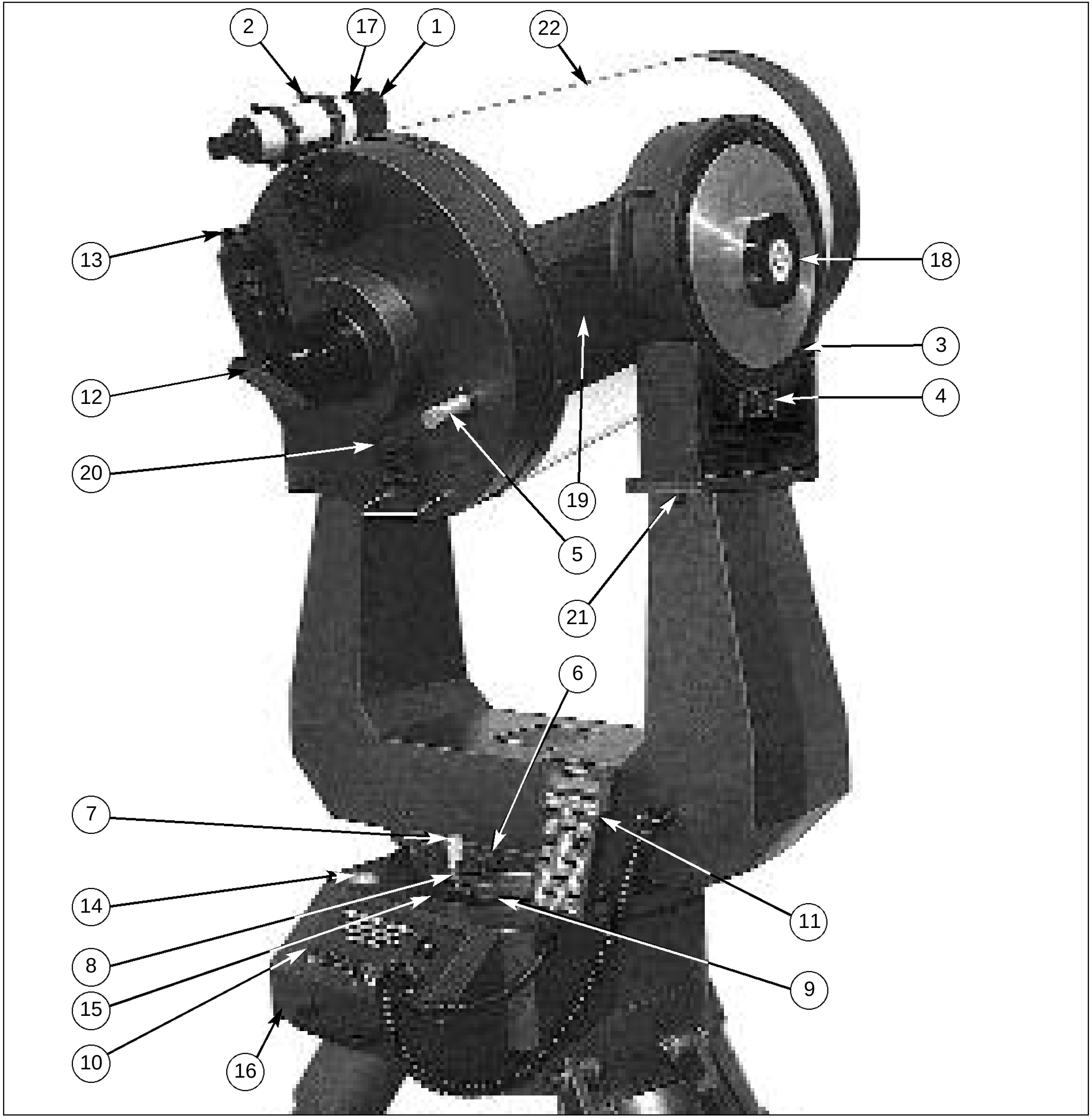


Fig. 1: Meade 16" LX200 Schmidt-Cassegrain Telescope.

Captions for Fig. 1

1. **Viewfinder Dew Shield**
2. **Viewfinder Collimation Screws**
3. **Declination (Dec.) Setting Circle**
4. **Dec. Vernier Pointer**
5. **Focus Knob**
6. **Right Ascension (R.A.) Lock**
7. **R.A.Slow-Motion Control Knob**
8. **R.A. Vernier Pointer**
9. **R.A.Setting Circle**
10. **Power Panel**
11. **Keypad Hand Controller**
12. **Diagonal Mirror**
13. **Eyepiece**
14. **Bubble Level**
15. **Hour Angle (H.A.) Pointer**
16. **Drive Base**
17. **Viewfinder Focus Lock Ring**
18. **Dec.Lock-Knob**
19. **Tube Adapter**
20. **Fan Filter**
21. **Optical Tube Assembly (OTA) Mounting Bolts (4)**
22. **OTA**

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16" LX200 Schmidt-Cassegrain Telescope

INTRODUCTION

As a new LX200 owner, you are preparing for a journey into the universe with the most advanced amateur telescope ever produced. This instrument is the culmination of twenty years of innovation and design at Meade Instruments. Never before have the features that you have in your hands been available to amateur astronomers: from robotic object-location to the revolutionary Smart Drive and the most stable mounting structure ever. Your telescope comes to you ready for adventure; it will be your tour guide and traveling companion in a universe of planets, galaxies, and stars.

Meade 16” LX200 Schmidt-Cassegrain Telescopes (SCT) are instruments of advanced mirror-lens design for astronomical and terrestrial applications. Optically and mechanically, the 16” telescope model is perhaps the most sophisticated and precisely manufactured telescope ever made available to the serious amateur. This telescope enables the visual astronomer to reach out for detailed observations of the planets of our Solar System and beyond to distant nebulae, star clusters, and galaxies.

The astrophotographer will find a virtually limitless range of possibilities. With the precision Meade worm-gear motor-drive system, long-exposure guided photography becomes not a distant goal but an achievable reality. The capabilities of the instrument are essentially limited not by the telescope, but by the acquired skills of the observer and photographer.

IMPORTANT NOTE

If you are anxious to use your LX200 for the first time, at the very least be sure to read TELESCOPE ASSEMBLY (page 7),and QUICKSTART (page 9).Thereafter, we urge you to read the balance of this manual thoroughly at your leisure, so you may fully enjoy the many features offered by this instrument.

What Is the LX200? An Overview

Meade LX200 SCTs mark a new era in telescope technology for the amateur astronomer, whether beginner or seasoned veteran. For the beginner, LX200 electronics permit the location and observation of the major planets as well as hundreds of deep-sky objects *the very first night you use the telescope*. For the experienced amateur, the telescope’s pushbutton electric slewing, digital readouts, Smart Drive, and many other features open up undreamed of visual and photographic capabilities.

1. Heavy-Duty Mounts with 4-Speed Dual-Axis Electronics

DC servo-motor-controlled worm-gear drives on *both* telescope axes permit observatory-level precision in tracking, guiding, and slewing (moving). The 4-speed dual-axis drives cover every possible contingency of telescope positioning. Press the SLEW button on the keypad controller for rapid motion of the telescope across the skies at up to 4° per sec. on both axes simultaneously. Once near the target, switch instantly to the FIND speed for centering in the viewfinder at 1° per sec. Observing the object in the main telescope, use the CNTR speed (16x sidereal) to place the object in the center of the field. During long-exposure astrophotography press the GUIDE button for precise corrections at 2x sidereal speed.

2. Built-in 64,359-Object Library

Enter into the keypad any object from the following object libraries, press **GO TO,** and the telescope automatically slews to the object at up to 4° per sec. and centers it in the main telescope field. The object libraries are as follows:

- 15,928 SAO stars (Smithsonian Astrophysical Observatory) Catalog of Stars: all stars brighter than 7th magnitude.
- 12,921 UGC (Uppsala General Catalog) galaxies: complete catalog.
- 7,840 NGC (New General Catalog) objects:* complete Catalog.
- 5,386 IC (Index Catalog) objects:* complete catalog.
- 21,815 GCVS (General Catalog of Variable Stars) objects: complete catalog.
- 351 alignment stars: LX200 alignment stars.
- 110 M (Messier) objects: complete catalog.
- 8 major planets, from Mercury to Pluto.

*NGC 2000 and IC databases are copyrighted by Sky Publishing Corporation and used with their permission.

3. Altazimuth Mode Operation

For all visual observing applications and for lunar and planetary photography, you may set up the telescope in the altazimuth mode. Just attach its drive base directly to the tripod, use the fast 1-star alignment procedure, and the telescope’s computer actuates 2-axis tracking. This keeps objects precisely centered in the field, even at high powers, during the entire observing session.

For long-exposure astrophotography, the telescope has an optional field de-rotator. It eliminates the image rotation caused by altazimuth tracking.

4. Terrestrial Operation

The Meade LX200 makes an incredible land-viewing telescope. Set it up in the atazimuth format, activate the Land menu option on the telescope’s computer, and use the keypad to track land objects on both axes at any of the same four drive speeds!

5. Keypad and Power Panel Functions

The multifunction capability of the LX200 includes the following:

Direct connection of popular CCD autoguider/imagers

RS-232 serial interface with a personal computer (PC), allowing you to perform all the keypad functions through, or write custom telescope software for, a PC

Brightness-level control of an illuminated reticle eyepiece from the keypad and special pulse-mode reticle operation

Electric focuser controls

HOME and PARK commands, which allow true remote observations

Smart Drive

Smart Drive is included on all Meade 16” LX200 Schmidt-Cassegrain telescopes. This technology is used to correct periodic error (errors induced by tiny gear imperfections that tend to slightly speed up or slow down the drive tracking speed, that occur in a regular four-minute pattern, or for every rotation of the worm) for enhancing the tracking characteristics of your LX200. This greatly simplifies guiding during astrophotography.

Most observing programs that the 16” LX200 will be used for, can be done with the telescope in an ALTAZ setup (explained later in this manual). ALTAZ operation incorporates both the horizontal movement and the vertical movement motors when tracking celestial objects through the sky. Since both of these motor/gear systems can have periodic error, Smart Drive monitors both axes, continuously correcting periodic error during tracking, a first in commercial telescopes.

When used as an equatorial telescope (described later), the

16” LX200 uses only one motor to track, and in this case Smart Drive corrects for periodic error in one axis only.

Smart Drive uses a model of the gear system to perform periodic error correction (minute correction to the tracking rate of each motor). This model is created at the factory and stored in non-volatile memory. Smart Drive activates automatically and transparently to the user.

Standard Equipment

The 16” LX200 includes the following:

- 16” Schmidt Cassegrain optical tube assembly (f/10) with super multi-coatings (D = 406.4mm, F = 4064mm f/10)
- Heavy-duty fork mount, with 6” diameter sealed polar ball bearing, quartz micro-processor-controlled 11” worm gears on both axes, and multi-function power panel display on the drive base
- Manual and electric slow-motion controls on both axes
- 4-speed drive control on both axes,
- PPEC Smart Drive on both axes
- Keypad hand controller with digital readout display
- GO TO controller, and 64,359-object software library
- Setting circles in Right Ascension (R.A.) and Declination (Dec.)
- Series 4000 SP 26mm eyepiece
- 8 x 50mm viewfinder
- #929 diagonal mirror (2"/1.25")
- 16" field tripod with leveling legs
- Operating instructions
- 25 ft. power cords for telescope operation from 115vAC

UNPACKING AND INSPECTION

As you begin to unpack your telescope from its cartons, you may wish to set it up right away. Please take a few minutes to read this page before doing so. You should verify that you have all the proper equipment and that it has reached you undamaged.

We strongly recommend that you keep your original packing materials. If you should ever need to return your telescope to the Meade factory for servicing, these will help prevent shipping damage.

Meade LX200 telescopes supplied to countries outside the U.S.A. are identical to those offered domestically, with the exception of the AC wall adapter.

What You Should Have

Carefully unpack and remove all the telescope parts from their packing materials. Compare each part to the Packing Program (packed with the telescope) to verify that you have each part. Place a check next to each item as you identify it. The Packing Program represents the original specifications for this instrument. Each telescope has been inspected twice at the factory to confirm the inclusion of every item.

Look Everything Over

Meade Instruments and your shipper have taken precautions to ensure that no shipping damage will occur, but if your shipment has suffered severe vibration or impact damage (whether or not the shipping cartons show damage), retain all the original packing and contact the shipper to arrange a formal inspection of the package or packages. This procedure is required prior to any warranty servicing by Meade Instruments.

Inspecting the Optics

CAUTION: Serious damage to the drive gears may result from shock in handling. During transport or commercial shipping,the R.A.lock (6,Fig.1) and/or the Dec. lock (18, Fig. 1) must not be engaged. Always release the locks when storing in the case or when crating for commercial shipment. This allows the telescope to give if the case or crate is sharply jarred or dropped.

The optical and mechanical axes of all LX200 telescopes have been carefully aligned at the factory to ensure accurate object pointing. Do not loosen or remove the optical tube assembly from the tube adapters (19, Fig 1).The resulting misalignment of the axes will result in inaccurate slewing of the telescope in the GO TO mode. ***Do not attempt to turn the focuser knob of the optical tube until you have read the following note.***

CAUTION: Next to the base of the focuser is a red slot-head bolt, used only for safety in shipment. Remove this bolt before attempting to turn the focuser knob. In its place, insert the rubber plug provided as a dust protector (this rubber plug is included with your hardware package).

The 16” LX200 should never be commercially shipped without the red bolt in place. This is essential during commercial transport, where rough handling may occur. Your transport and storage of the telescope will never require this bolt.

A Note on the Flashlight Test

If a flashlight or high-intensity light source is pointed down the main telescope tube, you may be surprised at the appearance of the optics. To the uninitiated, the view (depending on your line of sight and the angle the light is coming from) may reveal what would appear to be scratches, dark or bright spots, or just generally uneven coatings, giving the appearance of poor surface quality. These effects are only seen when a high-intensity light is transmitted through lenses or reflected off the mirrors. They can be seen on any high quality optical system, including the giant research telescopes in use today. The flashlight test casts even the very best optics in an uncomplimentary light. Optical quality cannot be judged by this test, but through careful star testing.

As the high-intensity light passes through the Schmidt corrector plate, most of it (about 98%+) is transmitted. The rest of the light scatters through the glass. As the light hits the mirrored surfaces, most of it (about 94%) is reflected back. The rest of it scatters across the coatings. The total amount of scattered light will be significant, and its effects allow you to see microscopic details that are normally invisible to the unaided eye. These anomalous details are real, but their combined effects will in no way impose limits on the optical performance, even under the most demanding observing or imaging criteria.

Commercial Reshipment

To re-ship the 16” LX200 commercially, be sure to follow this procedure:

1. Turn the focuser knob clockwise until it stops. This will bring the primary mirror all the way back in the tube.
2. Remove the rubber plug and insert the red bolt. Thread it in to a firm feel. Do not overtighten (if you have misplaced the red bolt, you may use any other bolt that is 1/4-20x1" long.)
3. **When packaging the 16” LX200, be sure to release the R.A. lock (6, Fig. 1) and Dec. lock (18, Fig. 1) to prevent shock to the gears in the motor assemblies should the package suffer rough handling.**

Commercial shipment of the 16" LX200 Telescope without the safety bolt in place and packed in the original factory supplied shipping containers as described above is done at the owner's risk and your warranty may be voided if shipping damage results.

TELESCOPE ASSEMBLY

Use the following procedure to assemble your telescope:

The 16" Field Tripod

The 16" Field Tripod (Figs. 2 and 3) for the Meade 16" LX200 telescope is supplied as a completely assembled unit, except for the spreader bar (4, Fig. 2) and the six lock-knobs (5, Fig. 2). There are two knobs for each of the three tripod legs. They are used to adjust the level of the tripod. These knobs are packed separately for safety in shipment.

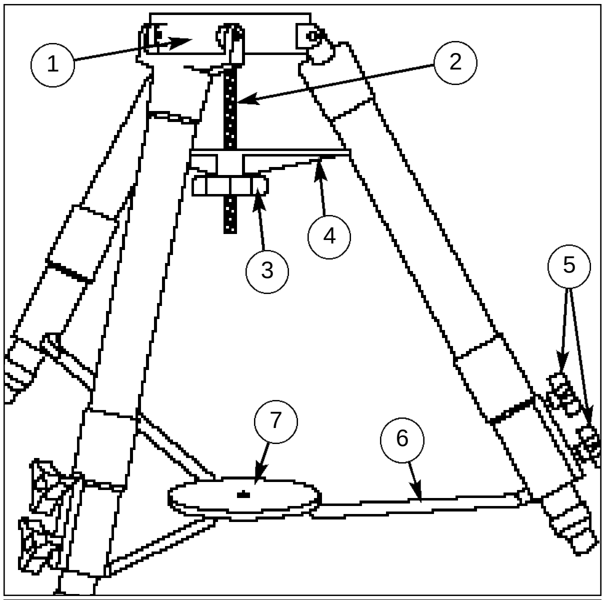


Fig.2: LX200 Field Tripod. (1) Tripod head; (2) Threaded rod; (3) Tension knob; (4) Spreader bar; (5) lock-knobs; (6) Extension strut; (7) Tension hub.

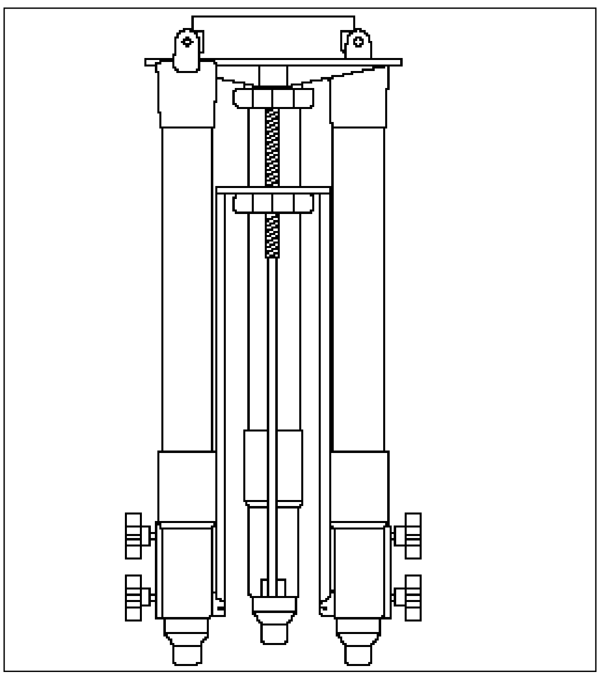


Fig.3: Field Tripod (collapsed).

For most observations, the drive base (16, Fig. 1) of the telescope's fork mount is attached directly to the 16" field tripod. The telescope is then mounted in an altazimuth (altitude-azimuth or vertical-horizontal) format. In this configuration the telescope moves along vertical and horizontal axes, corresponding respectively to the Dec. and R.A. axes (explained later in this manual) in an astronomical observing mode.

Alternately, the telescope can be mounted on a permanent pier, which is set for the latitude of the observing location (see **APPENDIX A** for instructions on using the telescope in equatorial mode). The equatorial mode permits alignment of the telescope's polar axis with the Celestial Pole (or North Star).

After removing the field tripod from its shipping carton, stand the tripod vertically, with the tripod feet down and with the tripod still fully collapsed (see Fig. 3). Remove the lower knob, releasing the tension hub (7, Fig. 2). This knob is used only when storing the field tripod. Moving one leg at a time, **gently** pull the legs apart. As the legs are opened, the tension hub will move down the threaded rod (2, Fig. 2) until it is free from the threaded rod. Continue to move the legs apart to a fully open position.

Thread in the two lock-knobs (5, Fig. 2) for each tripod leg, near the foot of each leg. These lock-knobs are used to fix the position of the inner tripod leg sections. These sections are used to level the telescope (described below).

NOTE: Tightening to a firm-feel is sufficient. Over-tightening may result in stripping of the knob threads or damage to the tripod legs. It gives no additional strength.

Loosen the tension knob (3, Fig. 2), holding the spreader bar (4, Fig. 2), and slide the spreader bar down the threaded rod until you can rotated it so that the three arms align with the three tripod legs. Tighten the tension knob; firm tightening of the tension knob is sufficient to result in rigid positioning of the legs. **Do not use force in tightening this knob.**

To collapse the tripod (after removing the telescope) for storage, follow these steps:

a. Loosen the tension knob and rotate the spreader bar 60° from its assembled position, so that one spreader bar arm is located between each adjacent pair of tripod legs.

b. Move the spreader bar to the top of the threaded rod. Tighten the tension knob, locking the bar.

c. Working one leg at a time, gradually collapse the legs of the field tripod until the tension hub is positioned onto the threaded rod. Use the second tension knob to secure the tension hub in place.

PRECAUTIONARY NOTES

- If the tripod does not extend or collapse easily, do not force the tripod legs in or out. If you follow the instructions above, the tripod will function properly. Forcing the tripod into an incorrect position may damage the extension strut system.
- Do not overtighten the six lock-knobs (5, Fig. 2) used to fix the inner tripod leg sections at various heights. Firm-feel tightening is sufficient; overtightening can damage the leg.
- Be sure the spreader bar (4, Fig. 2) is not upside-down on the threaded rod. See Fig. 3 for proper orientation.

Attaching the 16" Drive Base

a. Rotate the field tripod so that one leg is pointing approximately South (it need not point exactly South).

b. Position the 16" drive base (16, Fig. 1) onto the field tripod, with the power panel facing North, away from the South-facing tripod leg. Secure the drive base using the three 1/2"-13x1-1/2" long bolts. These bolts thread up through the underside of the tripod head (1, Fig. 2) into the drive base. Firmly tighten these bolts.

c. Level the drive base by loosening the six lock-knobs (5, Fig. 2) and sliding out the inner tripod legs until the bubble level on the drive base reads level.

Attaching the Fork

a. Place the single-piece fork onto the top of the drive base. One side of the base of the fork has a cut out to allow clearance for the R.A. lock (6, Fig. 1) and R.A. slow-motion control (7, Fig. 1), which are located on top of the drive base.

b. Bolt the fork to the drive base using the four 3/8"-16x1" long bolts (6, Fig. 5). Tighten to a firm feel only.

Mounting the Optical Tube Assembly (OTA)

This step requires two people who can lift up to 70 pounds each. The optical tube assembly (OTA) weighs about 125 lbs. and it must be positioned accurately in order to mount to the fork.

a. Located on the two top surfaces of the fork are two shoulder bolts. These two bolts function as locating pins for the OTA. On the inside edge of the Dec. castings are two matching holes (with slots). Before trying to mount the OTA, be sure to locate these two bolts and holes. Notice that the bolts and holes are located on one side of the castings, requiring the OTA to be mounted one way only.

b. Be sure that the Dec. lock-knob (18, Fig. 1) is tight (to a firm feel only). With you on one side of the OTA and your assistant on the other side, grasp the two handles on each side and lift the OTA onto the top of the fork. Position the holes over the shoulder bolts. When they are in place, slide the OTA back so that the shoulder bolts lock into the slots.

c. Lock the OTA in place using the four 3/8"-16x3/4" bolts (21, Fig 1). These four bolts thread up into the bottom of the Dec. castings, two on each side. Tighten to a firm feel only.

Mounting the Viewfinder

The 16" LX200 is supplied as standard equipment with an 8 x 50mm straight-through viewfinder. The bracket for this viewfinder is packed separately from the finder itself, and six black nylon thumbscrews (2, Fig. 1) for collimation (alignment) are pre-threaded into the viewfinder bracket. The viewfinder bracket mounts onto the telescope with a quick-release mount (see Fig. 1).

1. Attaching the Viewfinder

The viewfinder is shipped separately from the bracket and must be installed into the bracket. Slide the viewfinder into the bracket and lightly tighten the six collimation (alignment) screws (2, Fig. 1).

The quick-release mount allows the viewfinder to be attached or removed from the telescope easily. To attach the unit, slide the viewfinder with the bracket into the front of the mating base on the telescope, then tighten the two thumbscrews.

2. Focusing the Viewfinder

The viewfinder has been pre-focused at the factory. However, should it become necessary to adjust the focus, follow these steps:

a. Loosen the focus lock ring (17, Fig. 1).

b. While looking at a star, rotate the dew shield (1, Fig. 1) until the star is in focus (this refocuses the objective lens).

CAUTION: Take care when rotating counter clockwise. You are unthreading the dew shield; it may fall off if rotated too far. Refocusing the objective lens will require only a few turns of the dew shield at most.

c. When the dew shield is rotated to the sharpest focus for your eye, tighten the focus lock ring against the dew shield to fix its position.

3. Collimating the Viewfinder

The viewfinder will require collimation (alignment) with the main telescope. Using the 26mm eyepiece, point the main telescope at some easily found land object (*e.g.,* the top of a distant telephone pole) at least 200 yards away. Center this object in the main telescope. Then turn the six nylon collimation thumbscrews (2, Fig. 1) until the crosshairs of the viewfinder are precisely centered on the object already centered in the main telescope. With this collimation accomplished, objects located first in the wide-field viewfinder will then be centered in the main telescope's field of view.

Attaching the Diagonal Mirror and Eyepiece

The diagonal mirror (12, Fig. 1) threads directly onto the rear-cell of the 16" telescope and, in turn, accepts the supplied 1.25" (outer diameter) eyepiece. For astronomical observations, the diagonal mirror generally provides the most comfortable right-angle viewing position. With the diagonal prism, telescopic images appear correctly oriented up-and-down, but still reversed left-for-right. For terrestrial applications, where a fully corrected image orientation is desired—both up-and-down and left-right—the optional eyepiece holder and #924 Erecting Prism or #928 45° Erect-Image Diagonal Prism should be ordered separately. Eyepieces are held in place by a moderate tightening of the thumbscrew on the diagonal prism.

Attaching the Power and Data Cords

CAUTION: Always turn the power OFF before connecting or disconnecting any cables.

Several power and data cords are supplied with the 16" LX200. These should all be attached before powering up the telescope.

1. Confirm that the power switch on the power panel is OFF. Plug the 18-volt wall adapter into any 100vAC-to-240vAC power source. Then plug the 25-foot power cord into the wall adapter and the other end into the 18-volt power connector on the power panel.
2. Connect the large coil cord to the Dec. motor connector on the power panel and the Dec. motor connector on the lower part of the fork. This cord uses a DB-9 type connector and should be locked in place with the two thumbscrews supplied. This coil cord is reversible and can be connected with either end in either connector.
3. A short DB-9 cord (8" long) is supplied to provide power from the fork to the Dec. system. It is connected between the two DB-9 connectors located at the top of the right side of the fork and the Dec. casting.
4. Connect the keypad to the power panel using the small coil cord with the telephone connectors on each end.
5. If the fan will be used, connect the supplied coil cord from the fan to the 12vDC output jack.

Southern Hemisphere Operation

The 16" LX200 is shipped with the North/South jumper set for North (*i.e.,* with the jumper on one pin only). This jumper is located near the top left corner of the telescope's printed circuit board (1, Fig. 4). For Southern Hemisphere operation, move the jumper to cover both pins.

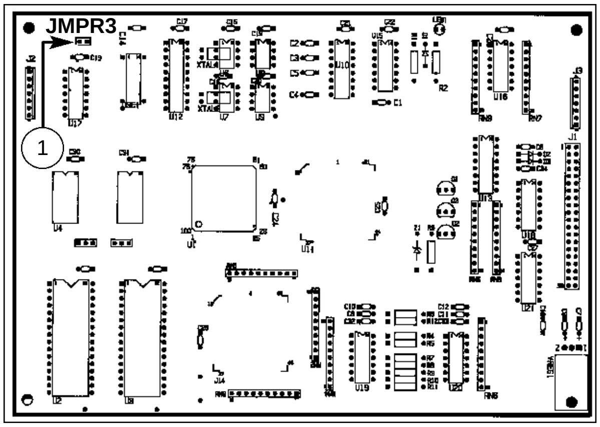


Fig.4: 16" LX200 Printed Circuit Board. (1) North/South jumper.

QUICK START

To utilize all the features of the telescope, enter the required information into the telescope's computer memory and learn the menu structure of the keypad hand controller, which is described in the rest of this manual. Although the LX200 electronics are advanced, the telescope is straightforward to operate.

If you are reading this manual for the first time and are anxious to begin observing through the telescope, this section will describe how to use the telescope without going through the rest of the manual. Come back and read the details, for most of the telescope's features can not be accessed without a full knowledge of these details.

Using the LX200 Manually

The easiest way to use the telescope is to operate it manually. With the telescope mounted on the field tripod (as described in **TELESCOPE ASSEMBLY**, page 7), and with the diagonal mirror and eyepiece in place, you are ready to make observations through the telescope. Even without the viewfinder (if it is not yet installed), terrestrial objects will be fairly easy to locate and center in the telescope's field of view with a low-power eyepiece by "gun sighting" along the side of the main telescope tube.

Unlocking the R.A. lock (6, Fig. 1) lets the telescope turn rapidly through wide angles in R.A.

NOTE: The terms Right Ascension and Declination will be discussed presently. For now, R.A.simply means horizontal and Dec.means vertical.

For fine adjustment in R.A., turn the R.A. slow-motion control knob (7, Fig. 1) while the R.A. lock is in the unlocked position.

The R.A. slow-motion control knob may be turned, if desired, with the R.A. lock in a partially locked position. In this way, a comfortable drag in R.A. is created. But do not attempt to operate the R.A. slow-motion control knob with the telescope fully locked in R.A.This may damage the internal gear system.

Releasing the Dec. lock-knob (18, Fig. 1), permits sweeping the telescope rapidly through wide angles in Dec.

CAUTION: Do not attempt to move the telescope manually in a horizontal direction when the R.A.lock is in the locked position.

With the above mechanical operations in mind, select an easy-to-find terrestrial object as your first telescope subject, for example, a house or building about one-half mile distant.

Unlock the Dec. lock-knob (18, Fig. 1) and R.A. lock (6, Fig. 1), center the object in the telescopic field of view, and re-lock the Dec. and R.A. locks. Precisely center the image by using the keypad arrow keys to move the telescope.

The focus knob (5, Fig. 1) is located at the four-o'clock position as you face the rear cell of the telescope. Precise motion of the telescope primary mirror focuses the image. As you turn the focus knob, there are no externally moving parts. Turning the focus knob counter-clockwise, you are focusing towards the infinity setting, and turning clockwise is for close distance. There are about 45 complete turns to go from one end of focus to the other, and it is possible to focus past infinity. Be patient during focusing as images quickly go in and out of focus with only a slight amount of turning of the focus knob.

Using the LX200 In LAND Mode

The 16" LX200 telescope is shipped with the microprocessor set to LAND mode. This is the align menu option that you will wish to use to view terrestrial objects. In this menu option, four motion speeds are active, allowing the telescope to be moved electronically by means of the keypad. To use the telescope in LAND mode, follow these steps:

1. Loosen the Dec. lock-knob (18, Fig. 1) and position the optical tube assembly approximately level, so that the Dec. setting circle (3, Fig. 1) reads 0°. Retighten the Dec. lock-knob.
2. Loosen the R.A. lock (2, Fig. 5) and rotate the telescope so that the R.A. Vernier pointer (4, Fig. 5) and the Hour Angle (H.A.) pointer (5, Fig. 5) approximately align with each other. This positions the fork arms so that they are parallel to the power panel (10, Fig. 1).

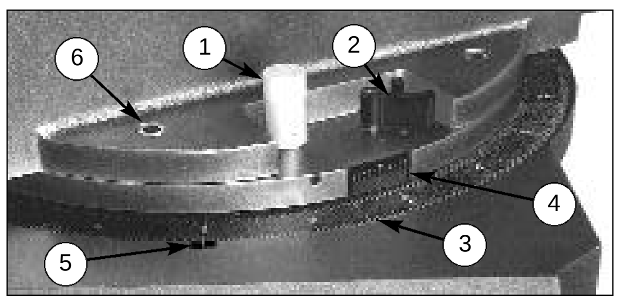


Fig. 5: 16"LX200 Azimuth System. (1) Slow-motion control knob; (2) R.A. lock-knob; (3) R.A. setting circle; (4) R.A. Vernier pointer; (5) Hour angle (H.A.) pointer; (6) Fork-mounting bolts.

The above two steps are not required for the telescope to work. The telescope has some illegal positions (places where the telescope will not go) and these two steps ensure proper operation.

3. After setting up the telescope, connect all cords as described in **Attaching the Power and Data Cords**, page 8.
4. On the power panel, turn on the LX200 power switch. The keypad display (1, Fig. 6) will show MEADE for several seconds as the microprocessor performs a diagnostic self-test. When the test is complete, the display shows TELESCOPE on the top line and OBJECT LIBRARY on the lower line. The red LED light next to the SLEW button will light up.
5. At this point the LX200 is ready to use. Select the speed at which you want to move the telescope by pressing the appropriate speed-selection key (4, Fig. 6). You will be able to see the telescope move only in the SLEW and MOVE modes.

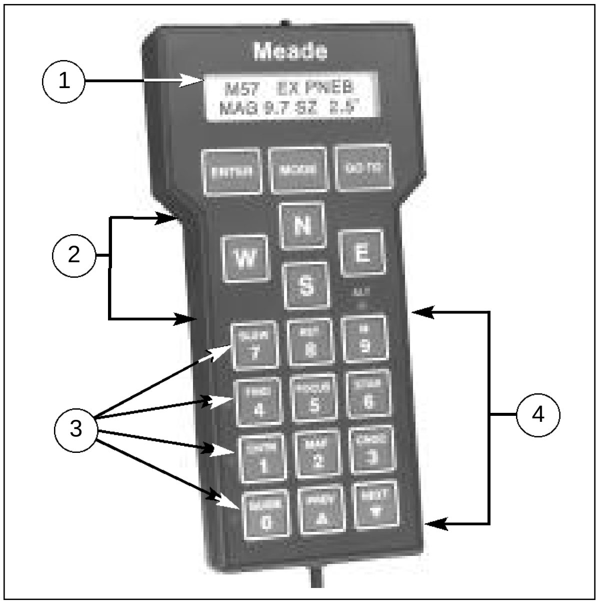


Fig.6: Keypad hand controller. (1) Display); (2) Direction keys; (3) Speed indicator LEDs; (4) Speed selection keys.

Motion Speeds

SLEW	(7)	=	4°/sec
FIND	(4)	=	1°/sec
CNTR	(1)	=	240 arcsec/sec
GUIDE	(0)	=	30 arcsec/sec

You can see CNTR (center) and GUIDE motions only while looking through the telescope. The red LED light next to the appropriate key (3, Fig. 6) lights, indicating the speed selected. Press one of the four direction keys (2, Fig. 6) to move the telescope in that direction at the selected speed.

You can move the LX200 manually with the R.A. and Dec. locks released or as described above. When the power is on, use only the N, S, E, and W keys on the keypad hand controller.

Using the LX200 In ALTAZ (Altazimuth) Mode

The two quick-start methods described above allow you to use the telescope, but they do not use the computer features available, including finding objects from the object library and automatic tracking of stars.

For these features to work, the telescope's power must be on, and the computer needs some basic information, which is entered through the keypad. Once entered, the information is permanently remembered by the telescope's computer and need never be entered again, even if the telescope is turned on and off.

This section explains which keys to push to get the minimum data required into the computer (see **MODEFUNCTIONS**, page 17, for detailed instructions). The steps detailed here take a few minutes and allow you to begin making using all the LX200 features.

1. Entering Basic Information

For the LX200 to make the conversions between the stellar coordinate system (R.A. and Dec.) and the altazimuth coordinate system (altitude and azimuth), it needs three pieces of information. This information must be entered once — the LX200 remembers data even when the power is off. However, check and reset the time, if necessary, at each observing session.

2. Location of the Observing Site

NOTE:The SITE information cannot be entered if the telescope is in LAND mode.

If the telescope is in LAND mode, the SITE menu option (display 2) will appear in lower case letters (see **Which Alignment Method to Use,** page 13). Follow steps 4 through 8 in **Setting up the Telescope**, page 11, to change the telescope's operation to altazimuth (ALTAZ) mode before proceeding.

You should find the position of your observing site to within one or two minutes of arc in both latitude and longitude. Many automobile, pilot, and topographical maps, as well as most atlases show latitude and longitude in 15-minute increments or better. The accuracy of the LX200 will depend on how close you get, so take a little time to get as accurate as you can.

Once you ascertain the above information, you can enter it into the telescope. It is easiest to enter the data with the telescope sitting on a table indoors—do not try to do it outdoors at night.

This section presents the steps without details or explanations to keep the process simple. Next to each step is a sample of what the keypad hand controller display (1, Fig. 6) should look like after each step.

As an example, we will enter the data for Irvine, CA (LAT = 33°35', LONG = 117°42'). If at any time you get lost, turn off the telescope and restart this procedure.

a. Turn the telescope power on. After a few seconds (after the diagnostic self-test completes), the display looks like Display 1.

Display 1

```
TELESCOPE
OBJECT LIBRARY
```

b. Press the **ENTER** key. This selects the TELESCOPE functions. The display should now look like Display 2.

Display 2

```
1) SITE
2) ALIGN
```

c. Press the **ENTER** key. This selects the SITE functions. The display should look like Display 3.

Display 3

```
1) A A A
2) A A A
```

d. Press and hold the **ENTER** key until the keypad hand controller beeps. This selects the first site for editing. The display should look like Display 4, with the first **A** flashing.

Display 4

```
1) A A A
2) A A A
```

e. Press the **ENTER** key. The display should look like Display 5.

Display 5

```
LAT    = +00°  00'
LONG   = 000°  00'
```

f. Use the number keys to enter your latitude. The underline designates the current cursor position. You can correct mistakes by moving back (using the E and W keys). Enter a negative latitude by positioning the cursor under the plus (+) sign and pressing the **NEXT** key (the lower right-hand key). When the latitude is correct, press **ENTER**. The display will look like Display 6.

Display 6

```
LAT    = +33°  35'
LONG   = 000°  00'
```

g. Use the number keys to enter your longitude as above. When complete, the display will look like Display 7.

Display 7

```
LAT    = +33°  35'
LONG   = 117°  42'
```

h. Press **ENTER** to complete the site information input. The display returns to Display 3.

i. Press MODE to return to Display 2.

j. Press MODE again to return to Display 1.

The longitude standard used in the LX200 starts at 0° in Greenwich, England, and increases toward the West to 359° 59 minutes. Many maps show Easterly longitudes that cannot be entered directly into the keypad display. If your map indicates that you are at an Easterly longitude of 18° 27 minutes, you would enter 341° 33 minutes.

Do not be concerned with differences in latitude and longitude as they pertain to different map spheroid projections. Those differences are too small to harm the latitude and longitude data input.

3. Local Time and Date

NOTE: A standard quartz clock controls the Time function on the 16" LX200 telescope. Like any timepiece, the internal clock of the telescope should be checked periodically and updated to keep it as accurate as possible.

Set the local time as accurately as possible, using the 24-hour format. The local time and date determine sidereal time (star time). The pointing accuracy of the telescope depends on the accuracy of the time entered. Choose a reliable source, such as your local airport or telephone company, as a reference for accurate time. In the USA you can double-check the accuracy of the exact minutes by dialing WWV for the universal coordinated time at (303) 499-7111 (be sure to enter your local time hour information, not the U.T. hour). For the example, we will use 2:40:00 P.M. on August 5, 2000.

a. The display should look like Display 1. If it does not, press the **MODE** key until it does.

b. Press the **MODE** key twice. The display will look like Display 8, but with a random LOCALand SIDE times.

Display 8

```
LOCAL = 11:24:30
SIDE  = 21:38:02
```

c. Press and hold the **ENTER** key until the keypad hand controller beeps (display like Display 9).

Display 9

```
LOCAL = 11:24:30
SIDE  = 21:38:02
```

d. Using the number keys, enter the current local time to within 5 seconds. (Remember, 2:40:00 P.M. is 14:40:00 in the 24-hour format.) Corrections can be made by moving the flashing cursor using the W and E keys. The display should look like Display 10. (*NOTE: The time should be checked and reset about once a month.*)

Display 10

```
LOCAL = 14:40:00
SIDE  = 21:38:02
```

e. Press the **ENTER** key when the time is correct. The display changes to Display 11.

Display 11

```
Hours from GMT:
+ 0 8
```

Enter the Greenwich Mean Time (GMT) time-zone shift by looking up your time zone in the following table:

U.S.A.TIME-ZONE SHIFT		
TIME ZONE	**STANDARD TIME**	**DAYLIGHT TIME**
HAWAII	+10 hours	+9 hours
PACIFIC	+8 hours	+7 hours
MOUNTAIN	+7 hours	+6 hours
CENTRAL	+6 hours	+5 hours
EASTERN	+5 hours	+ 4 hours
ATLANTIC	+4 hours	+3 hours

For example: If you live in the Pacific Time Zone and you are on Daylight Time, the GMT time shift is +7 hours.

f. Use the number keys to enter the GMT time-zone shift determined from the table above. Press **ENTER** when done; the display will go back to Display 8. If you are using the LX200 East of Greenwich,England, you must enter a minus (–) GMT time-zone shift by moving the blinking cursor backwards in the display with the **W** key and then pressing the **NEXT** key. The + (plus) sign will change to – (minus). Use the number keys to enter the Westerly (+) GMTtime-zone shift determined from the table above or your calculated Easterly (–) time-zone shift.

g. Press the **ENTER** key. This selects the DATE display (Display 12), with a random date showing.

Display 12

```
DATE = 07/11/91
```

h. Press and hold the **ENTER** key until the keypad hand controller beeps. The display will look like Display 13, with the blinking cursor over the first number.

Display 13

```
DATE = 07/11/91
```

i. Use the number keys to enter the current date. The display should look like Display 14. Use the W and E keys to move the blinking cursor left and right to correct any mistakes.

Display 14

```
DATE = 08/05/00
```

j. Press the **ENTER** key when the date is correct.

After you press the **ENTER** key, the keypad hand controller display **Updating planetary data**. The position of the planets depends on the date, so any time the date is changed, the planet positions are recalculated.

This is all the information the LX200 needs to use all features. The **next** steps align the telescope with the night sky.

4. Setting Up the Telescope

After the basic information has been entered into the telescope, the telescope is ready to set up and use. Follow **TELESCOPEASSEMBLY** (page 7) to set up the telescope outside, and follow these steps:

a. Using the bubble level (14, Fig. 1) located on the telescope's drive base, level the telescope. **The telescope's pointing ability depends on the telescope being level.** Make sure that the bubble is precisely centered by adjusting the length of the three tripod legs.

b. Loosen the Dec. lock-knob (18, Fig. 1) and position the optical tube assembly approximately level (so that the Dec. setting circle (3, Fig. 1) reads 0°. Retighten the Dec. lock-knob.

c. Loosen the R.A. lock-knob (2, Fig. 5) and rotate the telescope so that the R.A. Vernier pointer (4, Fig. 5) and the Hour Angle (H.A.) pointer (5, Fig. 5) are approximately in line with each other. This orients the fork arms parallel to the power panel (10, Fig. 1). Lock the R.A. lock-knob (2, Fig. 5).

Steps (1) and (2) are not required for the telescope to work; an approximation is sufficient. The telescope has some illegal positions (places where it will not go), and these two steps insure proper operation.

d. Turn the telescope on. After a few seconds (after the diagnostic self- test is complete), the display looks like Display 15.

Display 15

```
TELESCOPE
OBJECT LIBRARY
```

e. Press the **ENTER** key. This selects the TELESCOPE functions. The display should look like Display 16.

Display 16

```
1) SITE
2) ALIGN
```

f. Press the **NEXT** key. This moves the arrow to the lower line (see Display 17).

Display 17

```
1) SITE
2) ALIGN
```

g. Press the **ENTER** key to select the ALIGN function. The display looks like Display 18. (If the display looks like Display 19, with a checkmark next to ALTAZ, go to step 9.)

Display 18

```
1) ALTAZ
2) POLAR
```

h. Press the **ENTER** key to activate the ALTAZ mode. The keypad hand controller will beep and display a checkmark next to the ALTAZ (see Display 19).

Display 19

```
1) ALTAZ
2) POLAR
```

i. Press the **ENTER** key to use the checked mode (ALTAZ). The keypad hand controller display look likes Display 20.

Display 20

```
1 Star or
2 Star Alignment
```

j. Press **1** to select Star. The display screen looks like Display 21.

Display 21

```
Level base, then
press ENTER
```

k. If you have not already leveled the telescope, do so now. When the telescope is level, press **ENTER**. The display looks like Display 22.

Display 22

```
Press ENTER, then
pick align star
```

l. This message simply reminds you what you should do next. Press **ENTER** to show a display like Display 23.

Display 23

```
ACHERNAR
ACRUX A
```

m. Using the monthly star charts (**APPENDIX B**) pick an alignment star. Look at the chart for the current month and face the direction indicated. The constellations shown are easily found, even in the city. The charts are approximately 90° wide, with the top of the chart indicating straight up. If the time is after 9:00 PM, use the next month's chart. Once you identify the constellation, pick any of the labeled stars that is not within a 10° radius of overhead, but do not choose Polaris. Polaris (the North Star) is shown for reference only.

When you are aligning in ALTAZ, overhead stars can confuse the LX200 because of an illegal position that prevents the optical tube assembly from slewing past 90° altitude to protect the viewfinder from hitting the fork arm. The LX200 tracks an overhead object, but it does so by moving higher in altitude up to the illegal position, then the drive speeds up and moves 180° in azimuth so that the optical tube assembly can now be lowered in altitude to keep up with the overhead object.

Confusion arises because the LX200 does not know which side of 180° of azimuth it is on. Similarly, Polaris presents position problems in ALTAZ alignment because it is so close to the North Celestial Pole. In this region of the sky, the lines of R.A. are so close together that even the high-resolution encoders of the LX200 can yield ambiguous data.

In our example of August 5, we would use the August chart, face North, and look up about 45°. Cygnus is probably the easiest constellation to recognize, and we will use the star Deneb for our example.

Use the **PREV** and **NEXT** keys to scroll through the list of alignment stars until the arrow is positioned on Deneb (Display 24).

Display 24

```
CASTOR A
DENEB
```

n. Press the **ENTER** key to select Deneb. The keypad hand controller displays a message (Display 25).

Display 25

```
Center DENEB
then press ENTER
```

o. Center the alignment star (Deneb in our example) in the eyepiece of the telescope. You can move the telescope either of the following ways:

Manually by loosening the Dec. lock-knob and R.A. lock

Electrically by using the N, S, W, and E keys.

If moving the telescope electrically, use the speed keys, SLEW to get close, FIND to center in the viewfinder, and CNTR to center the star in the eyepiece. When the star is centered, press **ENTER**.

The telescope is now aligned and fully functional.

> The TELESCOPE and OBJECT LIBRARY features are accessed through a series of menus, which are shown on the hand controller display. You can scroll up or down through the list of choices by using the **PREV** and **NEXT** keys, and selecting the indicated menu option with the **ENTER** key. Menu choices that are shown in lower case letters are unavailable in the current operating mode (LAND, ALTAZ, or POLAR). If you try to select a lower-case menu option, the hand controller emits three warning beeps. **Three beeps indicates an attempt to perform an invalid telescope operation.**

The telescope will automatically begin to track objects. From this point, move the telescope only through the hand controller. Manual movements by loosening the Dec. or R.A. locks will cause the LX200 to lose position, requiring realignment.

5. MODE Key

The LX200 has five basic hand controller displays; the **MODE** key is used to move between them. The five modes are:

a. **Telescope Functions**. The TELESCOPE mode is where all telescope functions are changed or activated and the OBJECTLIBRARY is where the features of the object library are accessed.

b. **Telescope Position**. The first display shows the RA and DEC (telescope position in stellar coordinates) and the second display (accessed by pressing the **ENTER** key) shows the telescope position in ALTAZ coordinates.

c. **Time and Date**. The first display shows local and sidereal time and the second display (accessed by pressing the **ENTER** key) shows the date.

d. **Timer and Freq**. This display is a countdown timer; it allows you to change drive rates. These are advanced features.

e. **All Off**. This mode simply turns off all displays and backlighting. You can also adjust the backlighting brightness by pressing the **ENTER** key and using the **PREV** and **NEXT** keys to adjust the brightness.

6. Library Object Keys

While you are in any of the five main keypad display modes, you can directly access the library objects by using the M, STAR, or CNGC keys (see **APPENDIX C** for more information on the 64,359-object library). Press an object key and type in the number of the object desired, followed by **ENTER**. For example, a good first object for the first part of the year is M42 — the Great Orion Nebula.

Press the M key, the 4 key, the 2 key, and finally the **ENTER** key. The display will show data on the object (name, rating, object type, brightness, size). Now press **GOTO**. The telescope will automatically slew to M42.

OBJECT LIBRARY PLANETLEGEND			
PLANET	**STAR #**	**PLANET**	**STAR#**
MERCURY	901	**SATURN**	906
VENUS	902	**URANUS**	907
MARS	904	**NEPTUNE**	908
JUPITER	905	**PLUTO**	909

If the object entered is not above the horizon, the keypad hand controller will display the message **Object Below Horizon**.

Other good first objects (if above the horizon) are any of the M objects, from M1 to M 110, and the planets. Consult the following table to find a planet (*903 is the Moon.*)

Star Alignment

The 2-star initialization routines provide three options for aligning the LX200 telescope when in the ALTAZ mode.

*NOTE:The 2-star initialization routines apply only to the ALTAZ alignment mode (see **MODEFUNCTIONS**, page 17, for POLAR and LAND mode initialization).*

The first and second options require that you have entered the SITE and TIME information as described in **Entering Basic Information** (page 10). You can use the third option when you do not know the SITE information or have not entered it into the LX200's memory.

NOTE: In all alignment procedures, be sure the telescope is rotated so that the power panel is facing North.

1. 1-Star Alignment with Known SITE

The 1-star alignment routine is explained in detail in **Setting Up the Telescope** (page 11).

2. 2-Star Alignment at Known SITE

To use the 2-star alignment procedure at a known site, follow these steps:

1. Select 2-star alignment (by pressing the **2** key); the keypad display prompts you to level the base. This leveling step requires a rough level only and, unlike the 1-star alignment routine, does not affect the pointing accuracy of the telescope. See Section (d) below for a summary of the differences in telescope operation when selecting each of the three alignment procedures.
2. After leveling the base and pressing **ENTER**, follow the keypad display prompts to select the first alignment star. Slew to that star using the N, S, E, W keys.
3. Follow the keypad display prompts to choose and center the the second alignment star. Use the keypad to slew to the second star. After you press the **ENTER** key in the previous step, the keypad display shows the TELESCOPE/OBJECT LIBRARY screen.

Important Note: When you use either of the 2-star alignment procedures (at a known SITE or at an unknown SITE), choosing the proper two stars determines the pointing accuracy of the telescope. Choose two stars that are at least 90° apart. Do not use Polaris because R.A. changes very fast at the Pole and minor centering errors translate to large R.A. pointing errors. Also, avoid stars near the zenith (straight up) since azimuth changes very fast in this area.Generally speaking, choosing two stars as far apart as possible will yield very accurate pointing, often within a few arc minutes.

The LX200 calculates the distance between the two stars that you chose in the alignment steps and compares it to the distance that you actually slewed the telescope. This is a check to be sure that you centered the correct stars during alignment. Should the LX200 discover a discrepancy, the keypad will display: **Align Mismatch — Check Stars**. If you get this message after aligning the telescope, confirm that you are using the correct stars and align again.

3. Alignment with Unknown Site

To use the LX200 telescope at an unknown location, follow these steps:

1. Select site #5 (UNKNOWN) from the SITE menu.

*NOTE: You cannot edit this site like site numbers 1 to 4 as described in **Entering Basic Information**, page 10.*

2. Follow the keypad display prompts to select and center the two alignment stars.

As described above, the LX200 checks the accuracy of the two stars and displays **Align Mismatch — Check Stars** if it detects an error.

	1-Star Known	2-Star Known	2-Star Unknown
Pointing Accuracy Determined By:	Level of Telescope	2-Star Alignment	2-Star Alignment
Atmospheric Refraction Correction*	Yes	Yes	No
Atmospheric Refraction Correction Determined By:	Level of Telescope	Level of Telescope	Not Applicable
When Best Used	Best used when the telescope is permanently mounted and accurately leveled	Best used on a transportable telescope with the SITE information available	Best used when the SITE information is not available

*** Atmospheric Refraction Correction**: Light from an astronomical object is refracted (bent) as it passes through the atmosphere. This refracting is more pronounced near the horizon because there is more atmosphere for the light to pass through, and it shifts the apparent position of the star. The LX200 calculates this bending and compensates for it when slewing to objects near the horizon.

4. Which Alignment Method to Use

Each of the three methods described above has advantages and disadvantages. The following table summarizes these properties.

THE LX200 KEYPAD HAND CONTROLLER

The optics, mechanics, electronics, and software of the telescope are integrated in order to make you a better astronomer. Yet he system is mastered easily enough for the telescope to become a natural extension of the observer.

The LX200 gives you virtually every telescope function possible with every control in a compact hand-held console. The red LCD backlit keypad has tactile touch buttons (some of which are brighter than others), designed to have the right feel even if you wear gloves. Its red LCD backlit display, key arrangement, and easily understood information allow you to focus the telescope and your mind on the subject at hand.

The LX200 keypad hand controller is a dual axis drive corrector with the following features:

- Periodic error control
- An information display center for the computerized library
- A digital coordinate readout system
- A pulsing, illuminated-reticle eyepiece brightness controller
- A two-speed electric focuser controller
- A red LED flashlight!

Within a few minutes of power-up, the keypad becomes warm, which is normal for the system. The electronics utilize a heat sink to provide the correct operating environment temperature for the LCD display, even in sub-zero weather. If you are in these colder conditions, the display may not be visible until the keypad has transferred enough heat. This process can take a few minutes after power-up. While severe cold weather is not damaging to the electronics, keep the keypad in a warmer area to allow immediate proper display performance.

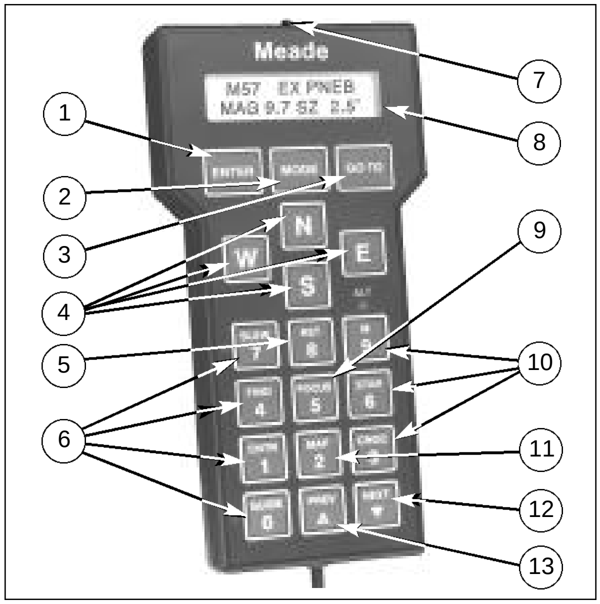


Fig.7: Keypad hand controller.
(1) ENTER key; (2) MODE key; (3) GO TO key; (4) Direction keys; (5) RETURN key; (6) Speed keys; (7) Red LED light; (8) Display; (9) Focus key; (10) Object keys; (11) MAP key; (12) NEXT key; (13) PREVIOUS key.

The LX200 keypad has the following keys:

ENTER Key

Use the **ENTER** key (1, Fig. 7) to select either a menu file or a file option or to edit a value. To select a file or an option, press and release the **ENTER** key. The LX200 emits a short beep and performs the action that you requested.

To edit a value, press and hold the **ENTER** key until you hear a double beep and a blinking cursor appears in the display. (The **ENTER** key is used in certain additional situations, which are described in detail later).

MODE Key

The **MODE** key (2, Fig.7) cycles through the five modes of the LX200. It is used to exit from specific menu files.

GO TO Key

The **GO TO** key (3, Fig. 7) causes the LX200 automatically to slew to specific library entry coordinates. The **GO TO** key also produces a blinking cursor in the **GO TO** menu file of the COORDINATES/GO TO mode. This lets you to enter new R.A. and Dec. coordinates.

Direction Keys

The N,S,E, and W keys (4, Fig. 7) make the LX200 move, or slew, in a specific direction. When you enter values, you can use the E and W keys to move the blinking cursor back and forth across the LCD display so you can correct errors.

The remaining 12 keys have multiple functions. Each one of these keys has alternate functions listed above the arrow symbols and numbers. The ALT LED light is visible only when you are entering numerical data.

Speed Keys (SLEW, FIND, CENTER, and GUIDE)

The SLEW, FIND, CENTER, and GUIDE keys (6, Fig. 7) let you set the rate of movement (slew) speed in the drives of the LX200, as activated by the N,S,E, and W keys. The speed-indicator illuminated LED beside the rate key that you press indicates the selected rate. The speeds are SLEW (4° per second), FIND (1° per second), CNTR (16X sidereal rate), and GUIDE (2X sidereal rate).

NOTE: Each slew speed drives the LX200 in all four directions, except for GUIDE. The 2X sidereal speed in GUIDE does not interrupt the R.A.tracking direction to make Easterly (for Northern hemisphere) or Westerly (for Southern hemisphere) adjustments; it will merely slow down the tracking drive to one half its normal speed. However, the slower drive moves the image opposite of the tracking direction, without disturbing the smooth drive action. This performance is essential when you are taking astrophotographs.

The SLEW, FIND, CENTER, and GUIDE keys also have numbers (7, 4, 1, and 0, respectively). You will use the multiple function of these keys when you edit a value. SLEW and FIND are also used to set the fast focus speed for the electric focuser accessory option, and CNTR and GUIDE set the slow focus speed. Other special functions for the CNTR and GUIDE keys are discussed below.

RET Key

Typically used for guiding the LX200 during an astrophotograph, the RET key (5, Fig. 7) is used to change the brightness and pulse rate of the optional corded-style illuminated-reticle eyepiece. Pressing either the **PREV** or **NEXT** (up and down arrow) keys while pressing the RET key alters the reticle-brightness level up or down.

When guiding on very faint stars, you may find it helpful to pulse the light from the LED so that the reticle crosshairs blink on and off. You can adjust the reticle brightness as well as the pulse rates. You can use three pulse rates, each with a one-second pulse interval. Set the continuous-illumination control and pulse rates by holding down the RET key and pressing one of the following keys: GUIDE (100% on, no pulsing), CNTR (50% on, 50% off), MAP (25% on, 75% off), CNGC (10% on, 90% off).

FOCUS Key

The FOCUS key (9, Fig. 7) allows two-speed electric-focus control of the optional Meade #1206 Electric Focuser (or equivalent corded electric focusers, such as the Meade Model #1200A). To activate, press either the SLEW or FIND key (for fast focusing) or the CNTR or GUIDE key (for slow focusing), press and hold the FOCUS key, and then press and hold the **PREV** or **NEXT** keys for near and far focus.

MAP Key

The MAP key (11, Fig. 7) turns on and off the red LED flashlight, which is located at the top of the keypad. The deep red LED light will protect your night vision while you search for an accessory or examine a star chart.

Object Keys (M, STAR, and CNGC)

The M (Messier objects), STAR (stars and planets), and CNGC (Computerized New General Catalog) keys (10, Fig.6) allow direct access to the LX200's object library any time that you are not editing a value, setting a parameter, or selecting a file menu. Use the object keys when you are at a top level of a mode. After you press one of these keys, the keypad display cursor blinks. It then lets you enter the catalog number for objects listed in the library (see **APPENDIX C**). After you enter the catalog number, press the **ENTER** key. To see the entered object, press the **GO TO** key.

The telescope has several object libraries; access them with the STAR and CNGC keys. When you press the STAR or CNGC keys, the display shows which object library you are currently in, and it waits for a number entry. To switch to a different library, press the **ENTER** key instead of entering a number.

The keypad display shows a menu of libraries available. Move the cursor to the desired library and press **ENTER** to select. The telescope remembers the database that you last accessed. Each time you press the STAR or CNGC keys, the same object database displays on the first line of the keypad display.

PREV AND NEXT Keys

The **PREV** key (12, Fig. 7) and **NEXT** (up and down arrow) key (12, Fig. 7) move the display LCD arrow up and down the menu files and menu file options so you can select an option. Use these keys also to adjust the RET brightness range or to activate the electric focuser. **PREV** and **NEXT** also work to select the objects from the object library when you use START FIND.

THE LX200 POWER PANEL

The power panel has a power switch and LED indicators showing power on with a current ammeter to show power draw. The power panel has all the connectors for the AC or DC power input, the DEC motor, and the keypad. There are connectors designed to accept optional accessories, such as the following:

CCD autoguiding camera
Optional Meade field de-rotator
Meade #1206 Electric Focuser
illuminated-reticle eyepiece.

Fig.8: 16" LX200 Power Panel. (1) Current (mAx 300) ammeter; (2) RS-232 port; 3) Field de-rotator port; (4) Focuser port; (5) Reticle port; (6) Keypad port; (7) ON/OFF switch, (8) 12v DC output (fan); (9) 18v DC power port; (10) CCD port; (11) DEC motor port.

A connector for RS-232 communication even lets you perform every function of the keypad from your personal computer.

ON/OFF Switch

When you move the ON/OFF switch (7, Fig. 8) to the ON position, the power light indicator, current ammeter, and keypad light up. The drive motors start, which momentarily pegs the ammeter, then the drive motors shift to a slower speed, which allows the R.A. worm gear to find its centering position for calibrating the Smart Drive before returning to an even slower tracking speed. The keypad display reads MEADE, then the version of the software appears briefly before defaulting to TELESCOPE/OBJECT LIBRARY. Within 15 seconds, the planetary orbital calculations with their corresponding apparent sizes and magnitudes and current stellar precession calculations are made. Every computer function is checked, and the LX200 diagnostics are complete.

Ammeter

The ammeter display (1, Fig. 8) is a series of vertical red LED bars. Each bar that is fully lit represents 0.3 Amp (300 milli-amperes) of current draw. The LED ammeter represents its lowest value on the extreme left of the scale. During normal tracking speeds, the ammeter shows about three fully lit LED bars and, at times, a fourth that is partially lit, indicating about 900 to 1000 milli-Amps or 0.9 to 1.0 Amps of current draw (when a slew is initiated the ammeter pegs the scale, momentarily showing the inertia load; this effect is normal).

The current draw information can be useful if you are trying to calculate how much battery life you will have during an observing session. For example, if the ammeter has four bars lit, indicating 1.2 amps, and you are using a 12-amp-hour battery, divide 12 by 1.2 to indicate a battery life of 10 hours.

DEC MOTOR Port

The DEC MOTOR port (11, Fig. 8) is a DB-9 socket, designed to accept the supplied coiled cord. One end of the coiled cord plugs into the power panel; the other plugs into the DEC. MOTOR socket in the right fork arm to power the Dec. motor.

CCD Port

The CCD Port (10, Fig. 8) allows direct interface from popular aftermarket CCD autoguiding/imaging cameras with their compatible connecting cables to accomplish autoguiding for non-attended astrophotography. The CCD cameras effectively watch a star and detect slight movements. When star movements are detected, signals from the CCD electronics make drive corrections in the LX200, to bring the star to a home position.

Most CCD autoguiding/imaging cameras are supplied with a cable that is compatible with the LX200 port. If your CCD unit does not have a cable, one can be obtained from the CCD manufacturer, or you can make your own cable using the following table.

CCD Connector Pin	LX200 Assignment
#1	Normally Closed
#2	West
#3	North
#4	Ground
#5	South
#6	East

Power 18 vDC Port

The power 18vDC port (9, Fig. 8) accepts either the standard-equipment AC converter or the optional DC power cord. The acceptable voltage range (under load) is from 12 to 18 volts.

Keypad Port

The keypad port (6, Fig. 8) is a 4-pin phone jack connector socket, designed to accept standard 4-pin phone jack cords. One end of the supplied coiled cord plugs into the keypad port; the other end plugs into the LX200 keypad.

Reticle Port

The Reticle port (5, Fig. 8) accepts optional accessory corded, plug-in style illuminated-reticle eyepieces, such as the optional Meade 12mm illuminated-reticle eyepiece or the Meade Series 4000 Plössl 9mm illuminated-reticle eyepiece (corded style). These let you set brightness and on/off pulsing rates from the LX200 keypad.

Focuser Port

The Focuser port (4, Fig. 8) accepts optional accessory corded, plug-in style electric focusers, such as the Meade #1206 Electric Focuser. These let you set electric focus from the LX200 keypad.

RS-232 Port

The RS-232 port (2, Fig. 8) provides for personal computer interface. This allows 9600 baud communications to access every feature of the LX200 keypad. Many popular astronomy programs directly interface with Meade LX200 telescopes. These include Meade's Epoch 2000sk Sky Software. **APPENDIX F** provides a wiring schematic to make the RS-232 cord, a cord test program, a demonstration program, and the LX200 command set for writing programs. Meade supplies this information for professional programmers. Meade does not offer support or advice for writing software for the RS-232 option.

Field De-Rotator (FDR) Port

The field de-rotator port (3, Fig. 8), for use in ALTAZ, lets you use the optional #1222 Field De-Rotator for long-exposure astrophotography by eliminating the image rotation inherent in altazimuth tracking.

12 vDC Output (Fan) Port

The 12vDC Output port (8, Fig. 8) is used to power the fan located on the optical tube assembly (OTA). This fan evacuates the warm air trapped inside the tube, allowing for faster cool-down.

CAUTION: This port can be used to power other 12-volt accessories, but maximum current output is 250mA.Do not attempt to use devices,such as heated dew shields, which draw more current than 250mA; they may damage the LX200 electronics.

This fan is controlled from the keypad, under TELESCOPE functions. The 12vDC Output port lets you operate the fan remotely from a PC.

The fan takes warm air from the OTA so that cool air can enter the OTA through the filtered hole (20, Fig 1) at the bottom of the OTA. The input filter prevents dust from entering the OTA. Periodically replace the filter by removing the four bolts holding the grill. The fan also has a filter, but this filter keeps dust out of the OTA while the fan is off; it should not need replacing.

MODE FUNCTIONS

To view the separate modes within the LX200 system, press the **MODE** key (it is located between the **ENTER** and GO TO keys at the top of the hand controller). You can customize the operation of your LX200 to perform virtually any of your observing requirements by entering and editing information in the various modes of the system. All the critical information, such as time, location, alignment type, and many other functions, are kept in memory—even with the LX200 turned off.

You can set the following through the five modes of the LX200 computerized hand controller:

Type of alignment
Objects that you see
Location from which you observe
Tracking speeds of the drives
Clock and timing functions
Position information
Brightness of the backlit keypad

Once you have selected the desired mode, you can select the individual file within the mode by pressing the **PREV** or **NEXT** key (up or down arrow key), as shown in Fig. 7. This scrolls the arrow up or down next to the file description. Although you will be able to see only two menu selections at a time on the keypad display, you will see more as you continue to press the **PREV** and **NEXT** keys.

When you select the file, press the **ENTER** key to view the file menu. To choose an individual menu, again use the **PREV** or **NEXT** key to move the arrow up or down the file menu. To explore a menu selection, again press the **ENTER** key. Some modes offer options for a file menu selection; others are only for entering data.

Whenever you wish to return to the main file heading in a mode, press the **MODE** key; it will behave as an exit key.

Mode One: TELESCOPE/ OBJECT LIBRARY

TELESCOPE/OBJECT LIBRARY is the mode to which the LX200 defaults after the instrument completes its power-on diagnostic self-test. The TELESCOPE/OBJECT LIBRARY mode is command central. It is where you select the way that you want the LX200 to perform mechanically and where you explore and select from its extensive library of stored objects.

To explore either the TELESCOPE menu file or the OBJECT LIBRARY menu file, move the LCD arrow to the appropriate selection by using the **PREV** or the **NEXT** key and press the **ENTER** key.

1. TELESCOPE Menu File

Below are the various selections of the TELESCOPE menu file, with illustrations of the individual menu files and file options.

a. **SITE:** The SITE menu option lets you enter up to four of your favorite viewing locations in latitude and longitude. To calculate celestial coordinates, the LX200 computer compares the llatitude and ongitude that you entered to your local time, GMToffset, and calendar date. Once entered, the information is stored in the telescope's internal memory; you need not re-enter it. To enter new site information or to change old information, see **QUICKSTART**, page 9.

You can choose any one of the four site options (or the UNKNOWN site) at your convenience, without entering latitude and longitude every time you use the LX200. Once you have chosen the site, exit the SITE menu by pressing the **MODE** key.

b. **ALIGN:** The Align menu selection of the TELESCOPE file demonstrates the unique ability to transform the LX200 into an altazimuth, celestial-tracking telescope, a polar-equatorial celestial-tracking telescope, or a land spotting scope with electric altazimuth movements within three options. These options are ALTAZ, POLAR, and LAND.

When you enter correct local time, latitude, and longitude (see **QUICKSTART**, page 9), you are ready to choose a type of alignment. Do this by pressing the **PREV** or **NEXT** key to move the arrow beside the desired option of ALTAZ, POLAR, or LAND, and then pressing the **ENTER** key. The display gives you instructions to walk you through the chosen alignment type.

1. **ALTAZ:** ALTAZ (altazimuth) requires that you mount the LX200 directly to the top of the field tripod (with the power panel facing North) and adjust the leg extensions of the tripod until the instrument is level. Then align on one or two of the bright stars in the look-up table of 33 alignment stars.

   This allows your LX200 to track in altitude and azimuth simultaneously for visual observations, very brief (under five minutes) exposure astrophotography, or CCD imaging (longer exposures require the field de-rotator).

   ALTAZ lets you access the object library as well as all other telescope functions, including the Smart Drive. Full instructions for using ALTAZ are in the **QUICKSTART** guide (page 9).

2. **POLAR:** POLAR allows you to use the 16” LX200 (mounted on a permanent pier set to your latitude) as an equatorial telescope. With the LX200 powered up, the POLAR file option selected, and the field tripod leveled, the telescope should be adjusted so that the Dec. setting circle (3, Fig. 1) is set to 90° (see Fig. 13), and the telescope is rotated to the 00 hour angle (H.A.) position in R.A. In this position, the viewfinder (Fig. 1) is upside down, and the following all line up:

   R.A. pointer (4, Fig. 5)
   00 line of the R.A. setting circle (3, Fig. 5)
   H.A. pointer (5, Fig. 5)

   (If you do not start at the 00 H.A. position, the telescope will point to the ground instead of the sky when the keypad display chooses its second star.)

   Press the **ENTER** key; the LX200 slews to the precise offset of the Polar star in Dec. and R.A.

   Aim the telescope at the Pole Star (Polaris, see **APPENDIX B** if the Pole Star is not visible). Center the Pole Star in the eyepiece field using only the altitude and azimuth adjustments on the pier. Press the **ENTER** key again; the LX200 chooses, and slews to, a very bright star that is overhead and can usually be seen in the field of view of the viewfinder. Center the bright star using only the R.A. and Dec. adjustments of the telescope (either manually by loosening the locks only or electrically); press **ENTER**. You can now access every function of the LX200.

3. **Refined Polar Alignment**:Astrophotographers routinely require polar alignments of the highest accuracy for the finest guiding characteristics. Refine your initial polar alignment by using the LX200's electronics with a slightly different method in the POLAR menu option. Perform the following steps at two or three 15-minute intervals. At each interval the telescope slews to the area where the Pole Star should be centered in the optics. The Pole Star may be somewhat off-center in the eyepiece.

This shows the alignment error that may have been made during your initial setup. Re-center the Pole Star during each interval using the pier adjustments only (see **APPENDIX A**) in altitude and azimuth, then follow the rest of the routine.

Return to the POLAR menu option in the TELESCOPE mode and press the **ENTER** key.

Ignore the keypad display instructions to return the telescope to 90° in Dec. and 00 H.A. Instead, press the **GO TO** key; the LX200 slews to the calculated position where the Pole Star should be.

Re-center the Pole Star in the field of view in the eyepiece using only the adjustments on the pier in altitude and azimuth.

Press the **ENTER** key; the LX200 slews again to a bright star overhead. Center this star using the N, S, E, or W keys, then press **ENTER**.

NOTE: Pressing the MODE key at any point in the alignment routine aborts the routine and exits to the top menu.

After each 15-minute interval, the Pole Star becomes more accurately centered. You can repeat the intervals as often as you like to obtain the highest accuracy. An optional illuminated-reticle crosshair eyepiece makes simplifies the job of centering the star.

When an obstruction blocks your line of sight to the Pole Star, press the **ENTER** key for the POLAR option (so that it has a check next to it). Follow the instructions in **Precise Polar Alignment**, page 27. You will need an illuminated-reticle crosshair eyepiece to complete the task. Once finished, follow the steps below for a permanently mounted LX200 section to access the object library.

4. **The Permanently Mounted, Polar Aligned LX200:** If you will permanently mount the LX200 in an observatory or use the already polar aligned telescope for several nights in succession, perform a high-precision polar alignment with one of the methods described above.

   Provided that you do not move the instrument on the pier, you need not perform polar alignment on successive nights. Access the object library and enjoy near-perfect tracking.

   To bypass the polar-alignment sequence, follow these steps:

   - Return to the POLAR menu option and place a check next to it by pressing the **ENTER** key.
   - Directly enter the catalog number of an object that you are familiar with in the sky by pressing the M, STAR, or CNGC key (see **APPENDIX C** for information on the object library) and press the **ENTER** key again.
   - Manually center the familiar object in the eyepiece of the telescope.
   - Press and hold the **ENTER** key until the display reads COORDINATES MATCHED.

   You have now synchronized the object library; the LX200 will correctly access every other object in the sky.

5. **LAND**: The LAND menu option transforms the ALTAZ (altazimuth) mounted LX200 into an electric slewing spotting scope. In this mode, continuous tracking is canceled and all the celestial modes and menus are non-functional, showing lower case lettering in the displays and a beep if you try to enter one of them.

   The LX200 slews at any one of the four speeds (SLEW, FIND, CNTR, and GUIDE), when you press the appropriately marked key on the left side of the keypad. Altazimuth coordinate readings can still be displayed in the COORDINATES mode (see **Mode Two**, page 23). Refer to **QUICK START** (page 9) for the LAND menu option for full operating procedures.

   For the normal right-side-up and left-to-right views to which you are accustomed when using a spotting scope, you may add the optional Meade #928 45° Erect Image Prism or the Meade #924 Porro Prism instead of the standard supplied star-diagonal prism

c. **HOME:** The HOME functions let you operate the LX200 from a remote location or to start the telescope without having to align it. After you set the HOME point, the telescope can determine all alignment parameters by finding the HOME point. To function correctly, this HOME alignment procedure requires the following three items of information:

   - One of the known SITES (1 to 4)
   - Either an accurately leveled telescope or accurately polar aligned telescope
   - Accurate sidereal time

   Since the HOME alignment routine is almost always used on telescopes that are permanently mounted, the first two requirements are already satisfied. For transportable situations, the HOME alignment procedure is practical only when the telescope remains set up for several nights. In this case, use the 1-star/leveled alignment if you want to perform a HOME alignment.

   The sidereal time is calculated every time an alignment is performed. Then, an on-board sidereal clock keeps sidereal time. Theoretically, every time you turn on the telescope, the sidereal time is correct, satisfying the third requirement for HOME alignment.

   However, the on-board clocks are accurate only to a few minutes per month. If you perform HOME alignment every night, the sidereal time will be accurate enough. If you operated the telescope only once or twice a month, make a habit of resetting the sidereal time before performing the HOME alignment.

   1. **Setting the HOME Point**: Before you can use the HOME alignment procedure, you must set the HOME point. This step needs to be performed only once on permanently mounted telescopes or anytime the telescope is moved.

      - Do a complete alignment, either the 1-star/leveled ALTAZ or the POLAR.
      - Using the keypad, move the telescope to 0° Dec. and 00 H.A.
      - Go to the HOME menu option and press **ENTER**. This will bring up the HOME menu.
      - Select the SET option by pressing the **NEXT** key twice; then pressing **ENTER**.

      The telescope moves back and forth in R.A. searching for the HOME sensor located inside the drive base. When it finds that sensor, it performs the same task in Dec. When that is complete, the message HOME SEARCH COMPLETE displays. The SET routine looks at only 30° sections of the gears; if the second step, above, is skipped or done incorrectly, the telescope will not find the sensors and HOME SEARCH FAILED displays.

2. **Using the HOME Alignment Routine**: Using the HOME alignment routine requires only two steps (assuming the SEThas been performed). First, before turning off power to the telescope, park the telescope by selecting PARK from the HOME menu. This will position the telescope to a known position, which the telescope remembers even when the power is off. Turn off the power.

   When turning the power back on, perform the FIND from the HOME menu. The telescope looks for the HOME sensors in both axes. When it finds them, it is ready for operation. As in the SETroutine, the telescope searches only 30° sections of the gears. If you forgot to PARK the telescope, or if it has been manually moved in R.A. and/or Dec., then perform step 2 in **Setting the HOME Point** before performing FIND home.

d. **12/24 HR**: The 12/24 HR menu selection of the TELESCOPE file toggles between a 12- and 24-hour display of local time in the Time mode.

   To toggle between 12- and 24-hour displays, move the arrow to 12/24HR and press **ENTER**. To return to the original setting, press **ENTER** again.

e. **HELP**: The HELP menu selection of the TELESCOPE file is an electronic mini-manual that briefly describes the function of each command key on the LX200 keypad. To use this menu, move the arrow with the **PREV** or **NEXT** key to HELP and press **ENTER**. To read the lines of text, use the **PREV** and **NEXT** keys. To exit, press MODE.

f. **REVERSE N/S**: The REVERSE N/S menu selection of the TELESCOPE file reverses the direction of the telescope in North and South movements (when you press the N key, the telescope moves South or down instead of North or up). This is especially useful during some guiding applications in imaging and observing.

   To use the REVERSE N/S menu, move the arrow to REVERSE N/S and press **ENTER**. To return the direction commands to the original setting, press **ENTER** again.

g. **REVERSE E/W:** The REVERSE E/W menu selection of the TELESCOPE file reverses the direction of the telescope in East and West movements (when you press the **W** key, the telescope moves East instead of West).

   To use the REVERSE E/W menu, move the arrow to REVERSE E/W and press **ENTER**. To return the direction commands to the original setting, press **ENTER** again.

h. **BALANCE:** When adding optional equipment, like a heavy camera, to the LX200, it is often necessary to rebalance the telescope using the Meade #1404 Tube Balance Weight Systems. Selecting option #8 from the TELESCOPE menu moves the LX200 telescope rapidly up and down in Dec. This provides an easy way to determine when the telescope is balanced in the Dec. axis (loosening the Dec. lock to check the balance will cause the LX200 to lose alignment.)

   When the telescope is out of balance, the LX200 draws more current while slewing in the heavy direction and the Dec. motor will sound different. After selecting option #8, watch the ammeter and listen to the Dec. motor to determine when the LX200 is balanced.

i. **HI-PRECISION:** The High-Precision Pointing feature of LX200 allows for very precise pointing of the telescope. With the unique LX200 SYNC command, 0.3 arc-sec resolution encoders, and high-speed DC servo motors, you can now place objects in the telescope's field of view with one arc-minute or better pointing accuracy. This makes critical image-placement applications, such as CCD imaging, possible.

   Normal telescope pointing accuracy is better than five arc-minutes when you perform a casual alignment. This is more than accurate enough for most observing applications. (A casual alignment is one that uses the UNKNOWN SITE or one that is done without the use of a reticle eyepiece to center the alignment stars exactly.) This type of alignment puts objects into the field of view of most eyepieces and is more than adequate for almost any visual observing application.

   A critical alignment improves the pointing accuracy of the telescope to two arc-minutes or better. This type of alignment requires accurate SITE information, time, date, proper selection of the two alignment stars, and a reticle eyepiece to center the alignment stars exactly. These steps generally require only a few extra seconds, yet they substantially improve the telescope's positioning. Critical alignment provides telescope positioning suitable for all but the most demanding pointing applications—including CCD imaging with larger-chip cameras, like the Meade Pictor 416 and Pictor 1616 CCD cameras.

   The HI-PRECISION feature increases the pointing accuracy of the LX200 to one arc-minute or better; it also requires the critical alignment described above. This yields the best pointing accuracy possible, placing objects into the active area of the even the smallest CCD cameras.

   For most applications, the HI-PRECISION feature is not required to get maximum enjoyment out of the telescope. For an evening of simple visual observations, the casual alignment is sufficient. Do not let pointing precision overshadow the fun of observing the night sky.

   The HI-PRECISION POINTING mode requires the critical alignment, described above, to maximize the telescope's pointing ability. The LX200 default condition is with HI-PRECISION disabled. To activate this mode, select the HI-PRECISION option from the TELESCOPE menu (option #9). When selected, HI-PRECISION change to upper case letters.

   When HI-PRECISION is active, the LX200 automatically does the following when a GO TO is initiated.

   1. HP will search the alignment star database and find the three closest stars to the object (or position) entered. This process takes about 10 seconds; the keypad shows Display 26:

      Display 26

      ```
      HI-PRECISION
       Searching. . .
      ```

   2. The telescope slews to the nearest alignment star. These are all bright stars (brighter than third magnitude); they are far enough apart to ensure that there will only be one in the field of view. The keypad display shows Display 27:

      Display 27

      ```
      Center STAR XXX
       then press GO TO
      ```

      Using a reticle eyepiece, center the star in the field of view. (Or center the star on the CCD chip if using a CCD camera.) Press **GO TO** when the star is centered.

NOTE: If this star is not in the field of view or if it is obstructed by a land object, the other two stars are available. Use the PREV and NEXT keys to cycle through the three closest stars.

   3. The telescope slews to the selected object or position.

j. **SLEW RATE:** Option #10 in the TELESCOPE menu is for changing the slew rate of the telescope. Slowing down the slew rate results in less noise when the telescope moves; it uses less power. To change the slew rate, follow these steps:

1. Press the **MODE** key on the keypad until the TELESCOPE/OBJECT LIBRARY menu appears. The cursor should be next to the TELESCOPE option — if not, press the **PREV** key to move the cursor up one space.
2. Press **ENTER** to select the TELESCOPE functions.
3. Press the **PREV** or **NEXT** keys to move the cursor to option #10: SLEW RATE. The right side of the display, shows the number 4. This represents the slew rate in degrees per second.
4. Press the **ENTER** key to change the slew rate. Each successive **ENTER** key press increments the slew rate by 1° per second.
5. After setting the desired rate, press the **MODE** key to return to the TELESCOPE/OBJECT LIBRARY menu.

NOTE: The slew rate is not stored in permanent memory. Reset it when the telescope powers up or accept the default rate of 4° per second.

k. **BACKLASH:** The BACKLASH feature is available only in the POLAR mode.

When taking long-exposure astrophotographs, guide the photograph to make sure the telescope is tracking perfectly. Otherwise stars will appear as ovals instead of pinpoints. Do this by setting the LX200 keypad to the GUIDE speed, monitoring the star location (*e.g.,* with an off-axis guider), and making small corrections to the telescope position by using the N, S, E, and W keys.

When you make these corrections, you speed up or slow down the R.A. motor (by pressing the E and W keys). The Dec. motor, however, when activated (by pressing the N and S keys) stops and reverses direction. Because of backlash in the Dec. motor gearbox, the telescope delays a few seconds when reversing direction.

The Dec. backlash feature compensates for the Dec. motor gearbox backlash and provides instant telescope movement when the motor is reversed.

To program the Dec. backlash, use this procedure:

1. Move to option #11 from the TELESCOPE menu. The keypad display will show:

   11) BACKLASH 00

   The 00 in the display shows the number of arc-seconds of backlash for which the LX200 is set to compensate (the default setting is 0 arc-seconds).
2. While observing a star at high power, time the Dec. movement delay when reversing the motor directions (by pressing the N and S keys). Typical values are two to four seconds.
3. The GUIDE speed for the Dec. motor is 15 arc-seconds per second. Therefore, multiply the number of seconds of delay by 15.
4. Press and hold the **ENTER** key for one second. The keypad beeps and a blinking cursor appears on the keypad display. Enter the number determined in step (c), above. Press **ENTER**.
5. Check the time delay as described in step (b). If there is a delay, increase the compensation number. If there is a slight jump when reversing direction, the number is too large.

   When reversing the direction in Dec., if the compensation number is correct, the telescope moves almost instantly. This compensation feature also works with popular CCD autoguiders, allowing for more accurate autoguiding. This number is stored in permanent memory; you need not re-set it.

l. **FDR**: The FIELD DE-ROTATOR (FDR) option is available only in the ALTAZ mode. Selecting this option activates the field de-rotator socket on the power panel. When it is active, the display shows the number of arc-seconds of field rotation for the part of the sky to which the telescope is pointing. When not using the de-rotator, turn off this function.

Field rotation can range from almost no rotation (at certain parts of the horizon) to infinity at the exact zenith (straight up). The #1222 Field De-Rotator has a practical limit of 120 arc-seconds per second. This creates a cone of just under 10° where the de-rotator cannot keep up with the field rotation. When taking exposures near the zenith, this number should be monitored and the exposure stopped should the field rotation approach 120 arc-seconds per second.

m. **FAN**: When the fan is plugged into the power panel, this switch will turn the fan on and off. The fan will aid in the temperature stabilization of the telescope. Extreme temperature variations will require about 30 minutes of fan operation to stabilize. During observations, the fan should be turned off to minimize any vibrations.

n. **DEC LEARN** and **DEC CORR** (Declination correction) You can correct for a star that drifts consistently North or South during guiding. Move the arrow to DEC LEARN and press **ENTER**. Begin making drive corrections immediately by pressing any of the direction (N, S, E, W) keys to keep the star on the crosshair of the guiding eyepiece. Train in DEC LEARN for at least half of your intended astrophoto exposure time. The longer you train, the more accurate DEC LEARN will be. Once you reach the desired time, press **ENTER** and the training ceases.

The telescope counts how many times you pressed the N and S keys. It chooses the direction based on the direction that received more commands, and it averages the time between key pushes in the chosen direction. Thus the telescope corrects for Dec. drift (should your polar alignment be slightly off) or increases the precision of your guiding on non-stellar objects, such as comets and asteroids.

To play back your DEC LEARN training, move the arrow to DEC CORRECTand press **ENTER**. To halt the playback press **ENTER** again. To erase the DEC LEARN training, either move the arrow back to DEC LEARN and press **ENTER** twice or turn the telescope off. DEC LEARN and DEC CORR are available only in POLAR mode.

2. OBJECT LIBRARY Menu File

The OBJECT LIBRARY menu file is the other half of the TELESCOPE/OBJECT LIBRARY mode. With it you can be a tourist of the sky or conduct research surveys of the 64,359 objects. The LX200 object library is accessible in the most effective and user-friendly system ever designed for observers and astrophotographers.

The core library, essentially a “greatest hits of the sky,” encompasses the planets of our solar system from Mercury to Pluto, 351 stars (doubles, variables, Pole Stars), the entire Messier catalog of 110 objects, 7840 of the finest galaxies, diffuse and planetary nebulae, and globular and open-star clusters.

The position epoch of these objects is for real time, updated each time you turn on your LX200. Even the planet’s positions have their orbits calculated. This qualifies the LX200 as the most accurate integrated object library available; it never requires updated software for precession of the stars or planetary orbital changes.

You can use the object library in the following ways:

Directly access the library by using the M, STAR, or CNGC keys (see **THE LX200 KEYPAD HANDCONTROLLER**, page 14) and entering a specific catalog number.

Use the START FIND option to find objects in organized strips of the sky that can be custom tailored to show only the objects that you wish to see with a selection of object types, size brightness.

Scan the sky and have the object library tell you what is in the field of view in the eyepiece by using the FIELD option.

Below is a description of the four OBJECT LIBRARY menu files and file options:

To access the OBJECT LIBRARY menu file, move the arrow to the OBJECTLIBRARY display by pressing the **PREV** or **NEXT** key while in the TELESCOPE/OBJECT LIBRARY mode. Press the **ENTER** key. You can access the four menu selections within the OBJECT LIBRARY by moving the arrow to the desired menu selection with the **PREV** or **NEXT** keys and performing the following steps.

a. **OBJECT INFO**: Press the **ENTER** key to read the type, brightness, size, and quality. Press **ENTER** again to read the coordinates. Press **ENTER** once more to determine how far off the telescope is pointing from the entered object (this is displayed in LCD bars: each bar is 10°, or if it is on the object, no bars). You can access the same information at any time by pressing the **ENTER** key for any object entered by the M, STAR, or CNGC keys. Press MODE to exit to the main menu file.

b. **START FIND**: The START FIND option resources the CNGC objects within the object library and begins a logical search, starting wherever the telescope is positioned when activated. To cover the entire visible sky, it will make 31 strip divisions of about 12° width, moving from West to East, from the North Pole to the South Pole, then South to North. Once it has found all the CNGC objects, it repeats its sequence until new objects are visible.

Press the **ENTER** key and the hand control displays the first object in its finding sequence. This object is selected by the LX200, based on where the instrument is pointing in the sky when you entered START FIND. To point your LX200 to the object displayed, press the **GO TO** key; it will slew to the object.

While in the START FIND option, you can either choose the next object in line or skip it. To find the next object in sequence, press the **NEXT** key; the display will show the new CNGC object. If you do not wish to view this object, press **NEXT** again. If you wish to return to a previously viewed object, press the **PREV** key until the desired catalog number is displayed and press the **GO TO** key. If you have set some limitations in the PARAMETERS option, the telescope will find only those objects within your chosen confines.

If you find that the object is not well centered in the eyepiece after you executing a GO TO (due to poor leveling, improper time input, or errors in site location), center the object; then press and hold the **ENTER** key until the display reads COORDINATES MATCHES. This feature synchronizes the LX200 for an area of the sky, so that the next object (if the leveling, time input, or site location information is not corrected) will be better centered, provided it is not too far away from the object to which you matched coordinates.

To exit the START FIND menu selection and return to the main menu, press MODE.

c. **FIELD**: Press the **ENTER** key to identify objects in the field of view of the telescope. The LX200 displays the object centered in the eyepiece field, and it shows how many other NGC objects are in the field at the same time (defined by the RADIUS parameter setting) as shown in Display 28:

Display 28

```
Objects: 5
Center: CNGC 4438
```

Press the **ENTER** key to see information about the object as shown in Display 29:

Display 29

```
CNGC 4438 VG GAL
MAG 10.1 SZ 9.3'
```

Read Display 29 as follows:

COMPUTERIZED **N**EW **G**ENERAL **C**ATALOG Object #**4438**, **V**ERY **G**OOD, **GAL**AXY, **MAG**NITUDE **10.1**, **S**I**Z**E **9.3'** (in arc minutes).

Press **ENTER** again to read the coordinate location of the object as shown in Display 30 (the * after the R.A. coordinate number indicates the catalog coordinates of the object, not necessarily where the telescope is pointing) :

Display 30

```
RA = 12:27.2*
DEC = +13'03
```

Press **ENTER** once more to see how far your telescope will have to move to acquire the object entered. The display shows LED bars, with each bar representing 10° of movement, as shown in Display 31:

Display 31

If you are centered on the object already (if you are in the FIELD menu selection or if you have made a GO TO command in one of the other methods for finding an object), the above display will be blank.To review any of the data on an object, continue pressing **ENTER** until the desired field appears.

You can use these commands in any of the following situations:

When you have an object entered in the keypad

While directly entering specific objects by pressing the M, STAR, or CNGC keys

In the START FIND menu selection

In the OBJECT INFORMATION menu selection

In the FIELD menu selection

d. **PARAMETERS**: Press **ENTER** at the PARAMETERS menu to find options that let you set such parameter limitations on the objects that you wish to locate as the following:

Type

Visual object quality range

Horizon

Zenith

Size

Brightness

Field of view

You can scroll through the PARAMETERS menu using the **PREV** or **NEXT** key. To edit, move the arrow to the desired option, and press and hold **ENTER** until you hear a double beep and see a blinking cursor (except in the BETTER option). Where numerical values are to be input, type them in from the keypad. If you make a mistake, you can move the cursor backward using the **W** key, and re-enter the data. To exit to the Main option menu, press the **ENTER** key once again.

1. The **TYPE GPDCO** option lets you select the type of CNGC objects that you wish to locate. Initially, the blinking cursor appears over the G symbol, for Galaxies. If you do not want to look for galaxies, press **NEXT**; the symbol changes from an upper case **G** to a lower case **g**. If you wish to keep GALAXIES selected, move the blinking cursor over to one of the other category symbols by pressing the **W** or **E** key on the keypad. You can then deselect the undesired categories.

   Parameter categories are abbreviated as follows:

OBJECT SYMBOL LEGEND	
SYMBOL	**DESCRIPTION**
G	GALAXIES
P	PLANETARY NEBULAE
D	DIFFUSE NEBULAE
C	GLOBULAR STAR CLUSTERS
O	OPEN STAR CLUSTERS

   If you wish to recall a category symbol, move the blinking cursor over the symbol and press the **PREV** key. After your selections are made, press **ENTER**.

2. **BETTER**: The BETTER option lets you define the visual object quality range. At power-up, the range is set at the bottom of the scale, on VP for VERY POOR. The START FIND option will select all objects that are very poor through super or what could be considered an ALL setting. The object-quality symbols are as follows:

OBJECT-QUALITY SYMBOL LEGEND	
SYMBOL	**DESCRIPTION**
SU	SUPER
EX	EXCELLENT
VG	VERY GOOD
G	GOOD
FR	FAIR
PR	POOR
VP	VERY POOR

   If you wish to define the object quality range to Very Good and better, press the **ENTER** key until the symbol VG is displayed. From the VP setting to VG requires three **ENTER** key presses. The LX200 now selects objects that look Very Good through Super.

3. **HIGHER:** The Higher option sets the horizon setting for the telescope. At power-up, the setting is 00°, which assumes that you have an unobstructed line of sight to the horizon in every direction. If, however, there are obstructions to viewing a level horizon or if the sky quality is poor due to haze or light pollution, you can set an artificial horizon level. Your LX200 will not try to find objects below your setting.

   Enter the number of degrees above the horizon that will clear the obstructions in the sky. To estimate how many degrees the obstruction is taking up of the sky, hold your fist at arms length. Each fist diameter is approximately 5°. So, if a tree is three fists high, you would set 15° in the HIGHER option. Once the setting is finalized, press ENTER.

4. **LOWER:** The LOWER menu file option sets the zenith limit setting for the telescope. At power-up, the setting is 90°, which assumes that you point the telescope straight up. If, however, you have instruments on the telescope which will not clear the fork arms, or if you want to avoid the 10° field de-rotator limit, this setting can be used.

   Enter the number of degrees from the zenith that you want to limit. Once the setting is finalized, press **ENTER**.

5. **LARGER:** The LARGER menu file option allows settings of the lower apparent size limit of the objects you wish to see. At power-up it is set to 000' (arc minutes). In order to make a decision as to the size limits that you may impose, it helps to have a clear understanding of exactly what an arc minute of sky is. A good example is the apparent size of the Moon, which could be expressed as 1/2 of a degree, 30 arc minutes, or 1800 arc-seconds. Each arc minute is 60 arc-seconds, and there are 60 arc minutes for each degree of sky.

   Some beginning observers have a tough time discerning objects less than about 1 arc minute in size unless it is a double star or a planet. Astrophotographers and those involved with CCD imaging may want to set a higher value based on the desired image scale coverage that would be most impressive with different types of films or CCD cameras. Enter the new value in arc minutes, then press ENTER to exit to the option file.

6. **SMALLER:** This menu option is the upper size object limit. At power-up the setting is for 200 arc minutes or 3.33°. This setting is high enough to cover the largest objects in the OBJECT LIBRARY.You may want to lower the value because of true field-of-view limitations of a particular eyepiece (see the RADIUS parameter option for calculating true field).

   Other reasons for limiting the value in SMALLER is for astrophotographic or CCD imaging requirements where we don't want the object to exceed the imaging area of the film or the CCD chip.

7. **BRIGHTER:** The lower brightness limits based on stellar magnitude can be limited in the BRIGHTER menu. At power-up, the magnitude value is at a very faint level: +20.0.

   You may want to adjust the magnitude level to a brighter value, starting at perhaps the limiting visual magnitude of your LX200, which is approximately 15.5 for the 16" LX200. If you are taking astrophotographs, the limiting magnitude is about 18.0. Sky conditions (haze, high clouds, light pollution) also greatly affect the limiting magnitude.

8. **FAINTER:** You may also adjust the upper level of brightness with the FAINTER menu file option, (you may find few applications for limiting it to a lower value).

9. **RADIUS:** The RADIUS value sets the following boundaries regarding objects that the LX200 recognizes in a given eyepiece while in the FIELD menu:

   Which objects the LX200 recognizes

   How many objects the LX200 recognizes

   At power-up the RADIUS menu file option is set to 15 arc minutes.

   To calculate the **true field of an eyepiece**, first divide the focal length of the telescope (*e.g.,* 4064mm for a 16" f/10) by the focal length of the eyepiece (the standard supplied eyepiece is a 26mm Super Plössl, 4064 divided by 26 equals 156x magnification). Then find the apparent field of the eyepiece (which is 52° for the 26mm Super Plössl) and divide it by the magnification (52 divided by 156 equals 0.33°, multiplied by 60 equals 20 arc minutes).

   To get the **radius of the true field of view**, divide the true field by 2. In the case of the above equation, 20 arc minutes divided by 2 equals 10 arc minutes.

Mode Two: COORDINATES/GO TO

Mode Two (COORDINATES/GO TO) lets you see where you have pointed the LX200 in two celestial coordinate formats, either R.A. and Dec. or altazimuth. In this mode you can enter new R.A. and Dec. coordinates for any sky position. Thus you can locate objects, such as comets or asteroids, that may not appear in the LX200 library and have your telescope slew to the new coordinates.

1. Coordinates Menu File

At first you will see the R.A. and Dec. coordinates of where the telescope is pointing. If you move the LX200 with the N, S, W, or E keys, the display of coordinates immediately updates the new position in R.A. and Dec.

You can also display computed information of the altazimuth coordinates (**ALT** and **AZ**) by pressing the **ENTER** key. To return to:the R.A. and Dec. coordinates, press the **ENTER** key again.

The R.A. display consists of hours, minutes, and tenths of a minute; the Dec. display consists of into **+** for North Dec. and **–** for South Dec., in degrees and minutes, as shown in Display 32:

```
RA = 02:45.9
DEC = +22'54
```

Display 32

If you have made an **ALTAZ** style of alignment, the **ALT** and **AZ** coordinate display is formatted as follows:

0° azimuth (AZ) is due South; it increases to up to 359° and 59 minutes moving clockwise, or from due South moving Westerly. Altitude (ALT) is formatted so that straight overhead is +90° and 00 minutes, decreasing to +00°, and 00 minutes as you move the telescope level with the horizon; then as the LX200 moves below +00.00 it will give minus altitude readings. Display 33 shows the altazimuth coordinate display.

```
ALT = +72'50
AZ =    158'10
```

Display 33

When you slew in one direction in ALTAZ, the **RA** and **DEC** displays change at the same time. The **ALT** and **AZ** displays change only in the direction that the telescope is slewing.

NOTE:Only the Dec.setting circle (3, Fig.1) gives a correct reading. The R.A. setting circle (9, Fig. 1) gives correct readings only in the POLAR setting (see APPENDIX A).

2. GO TO Menu Option

The GO TO menu option lets you enter new R.A. and Dec. coordinates of any object in the sky, so that the LX200 will slew to the new position. With this ability, your LX200 knows no bounds. You can easily find any celestial objects, including comets and asteroids, provided that you have accurate coordinate-reference data.

To enter a new pointing position in R.A. and Dec., press the **GO TO** key. You will hear a double beep, then see a blinking cursor over the **RA** coordinate numbers. Type in the new R.A. coordinates, then press the **ENTER** key. The blinking cursor is over the **DEC** coordinates. Enter the new Dec. coordinates, then press the **ENTER** key. The LX200 slews to the new coordinate position.

You can also slew to ALTAZ coordinates from the ALTAZ display as described above.

If you need to enter a minus Dec. setting, do the following:

Move the blinking cursor over the **+** sign with the **W** key.

Press the **NEXT** key to get the **–** (minus) sign .

Move the blinking cursor to the first number with the **E** key.

Enter the new coordinates.

If you are already at a minus (–) Dec. setting and wish to enter a plus (+) Dec. setting, follow the same instructions as above but press the **PREV** key to get the **+** sign .

Mode Three: CLOCK/CALENDAR

The continuously operating clock and calendar are the life pulse of your LX200. At power-up, the telescope's sidereal clock automatically lets the system computer calculate orbits of planets and precessions of stars for superior pointing ability.

You need not re-enter local time and date need each time you use the LX200; it has a long-life lithium battery back-up. To set the local time and date and to enter the correct GMT offset, see **QUICK START**, page 9. Use your local hour setting appropriately in either 12-hour or 24-hour format, as predetermined by the 12/24 HOUR TELESCOPE menu file option.

The long-life lithium battery (Panasonic CR2032 3vDC or Duracell DL2032B) is stored behind the power panel of the drive base (see **APPENDIX D: Behind the power panel** for battery-replacement information).

Mode Four:TIMER/FREQ

1. The TIMER Option

The **TIMER** menu option is for accurately timing different observing or imaging tasks for up to 12 hours. The system counts down to zero, in the hours, minutes, and seconds format, and beeps to notify you that the time is up.

To set the TIMER, move the arrow to:

TIMER = 00:00:00

Press and hold the **ENTER** key to receive the double beep and the blinking cursor. Enter the number of hours, minutes, and seconds that you require. If you need to correct an error in entry, use the **E** and **W** keys to move the blinking cursor; then type the correct information. After entry, press the **ENTER** key again; the cursor disappears. When you are ready to start your time countdown, press the **ENTER** key once more. To pause the countdown, press **ENTER** again, and then again to resume.

If you want an automatic 12-hour countdown, press and release the **ENTER** key. Then press **ENTER** to start the countdown.

2. The FREQ (Frequency) Option

The **FREQ** (Frequency) option lets you adjust the tracking speed (not slew speed) of the LX200 digitally in tenths of a Hertz, from 56.4 Hz to 60.1 Hz. You can match virtually every celestial motion in the sky. Some popular drive rate settings are:

FREQ RATE	DESCRIPTION	NOTES
60.1 Hz Q	Sidereal rate; Quartz setting	Default rate at power-up. Gives sidereal frequency accuracy to ±.005%; Best for astrophotos
60.0 Hz	Solar and planetary rate	Average rate for tracking planets; Actual rates vary due to retrogrades, oppositions, etc.
57.9 Hz	Lunar rate	Best rate for tracking the Moon

There are three options in the **FREQ** menu. To see or set the options, move the arrow to **FREQ** and press **ENTER**. At power-up, the **FREQ** default is the 60.1Hz Q setting. The quartz rate is precisely fixed and cannot be altered. To choose a different rate, press the **ENTER** key to see 60.1M, and then again to see 60.1 M with the up and down arrow. These two menu file options can adjust the tracking speeds.

Adjusting the Tracking Speed

Display 34 shows the manual rate menu file option that you can adjust by pressing and holding the **ENTER** key to get the double beep and the blinking cursor. Type in the new rate and press the **ENTER** key again.

FREQ = 60.1 M

Display 34

Display 35 shows the menu file option that lets you step the drive tracking frequency setting in tenths of a hertz, by using the **PREV** and **NEXT** (up and down arrow) keys. This is a convenient feature if you are trying to match the precise speed of a planet, comet, or any other non-stellar object. To exit this option, press the **MODE** key.

FREQ = 60.1M

Display 35

Mode Five: KEYPAD OFF/BRIGHTNESS ADJUST

In order to see very faint objects, you may need either to dim or turn off the keypad red LCD backlighting. To do so press the **MODE** key until the display goes blank. This is the OFF option.

To set the keypad brightness, press the **ENTER** key and adjust the brightness with the **PREV** and **NEXT** keys. To exit, press the **MODE** key.

This brightness setting also dims the power panel power LED and ammeter.

NOTE:The backlighting is done by edge lighting a plastic light bar underneath the keypad. Four LEDs are used and do not give a perfectly even backlighting of the keys. Keys closer to a LED are a little brighter than keys further away.

MAGNIFICATION AND FIELD OF VIEW

Magnification

The magnification (power) of the telescope depends on two characteristics: the focal length of the main telescope and the focal length of the eyepiece used during a particular observation. For example, the focal length of the 16" LX200 f/10 telescope is fixed at 4064mm. To calculate the power in use with a particular eyepiece, divide the focal length of the eyepiece into the focal length of the main telescope.

Example: The power obtained with the LX200 with the SP 26mm eyepiece is:

$$\text{Power} = \frac{4064\text{mm}}{26\text{mm}} = 156\text{X}$$

The type of eyepiece (MA for Modified Achromatic, PL for Plössl, SP for Super Plössl, etc.) has no bearing on magnifying power. It affects such optical characteristics as field of view, flatness of field, and color correction.

The maximum practical magnification is determined by the nature of the object being observed and especially by the atmospheric conditions. Under very steady atmospheric seeing conditions, the 16" LX200 may be used at powers up to about 800X on astronomical objects. Generally, however, lower powers, 300X to 400X, are required for high image resolution. Under unsteady atmospheric conditions, as witnessed by rapid twinkling of the stars, extremely high power eyepieces result in empty magnification, where the object detail observed is diminished by excessive power.

When you begin observing an object, start with a low-power eyepiece. Get the object well centered in the field of view and sharply focused. Then try the next step up in magnification. If the image starts to become fuzzy as you work into higher magnifications, then back down to a lower power (as when the optometrist asks, “Is this lens better or worse?”). A bright, clearly resolved but smaller image shows more detail than a dimmer, poorly resolved larger image.

The characteristics of the human eye (particularly eye-pupil diameter) and telescope optics impose minimum practical powers. Generally, the lowest usable power is approximately 4X per inch of telescope aperture, or about 64X in the case of the 16” telescope. In daytime, when your pupil is reduces to avoid glare, the minimum practical power with the 16” LX200 increases to about 120X.

Avoid powers below this during daytime observations. A reasonable magnification range for daytime terrestrial observations through the 16” LX200 is from about 150X to 200X. The higher magnifications may not be practical during atmospheric disturbances, such as those caused by heat, moisture, and dust.

Accessories are available to increase and decrease the operating eyepiece power of the telescope. See your Meade dealer and the latest Meade Catalog for information on accessories.

Apparent Field and Actual Field

Apparent Field, the field of view that your eye perceives through an eyepiece, depends on eyepiece design.

Actual Field, your actual field of view, depends on the eyepiece and the telescope. Calculate the Actual Field of a telescope with a given eyepiece by dividing the Apparent Field of the eyepiece by the power obtained using that

	8”f/10	**10”f/10**	**12”f/10**	**16”f/10**
Eyepiece/Apparent Field	Power/Actual Field	Power/Actual Field	Power/Actual Field	Power/Actual Field
Super Plössl Eyepieces (5-elements; 1.25” O.D., except as noted)				
6.4mm/52°	313/0.17°	391/0.13°	476/0.11°	635/0.08°
9.7mm/52°	206/0.25°	258/0.20°	314/0.17°	419/0.12°
12.4mm/52°	161/0.32°	202/0.26°	246/0.21°	328/0.16°
15mm/52°	133/0.39°	167/0.31°	203/0.26°	271/0.19°
20mm/52°	100/0.52°	125/0.42°	152/0.34°	203/0.26°
26mm/52°	77/0.68°	96/0.54°	117/0.44°	156/0.33°
32mm/52°	63/0.83°	78/0.67°	95/0.55°	127/0.41°
40mm/44°	50/0.88°	63/0.70°	76/0.53°	102/0.43°
56mm/52° (2" O.D.)	36/1.46°	45/1.16°	54/1.04°	73/0.71°
Super Wide Angle Eyepieces (6-elements; 1.25” O.D., except as noted)				
13.8mm/67°	145/0.46°	181/0.37°	221/0.30°	294/0.23°
18mm/67°	111/0.60°	139/0.48°	169/0.40°	226/0.30°
24.5mm/67°	82/0.82°	102/0.66°	124/0.54°	166/0.40°
32mm/67° (2" O.D.)	63/1.07°	78/0.86°	95/0.71°	127/0.53°
40mm/67° (2" O.D.)	50/1.34°	63/1.07°	76/0.88°	102/0.66°
Ultra Wide Angle Eyepieces (8-elements; 1.25” O.D., except as noted)				
4.7mm/84°	426/0.20°	532/0.16°	649/0.13°	865/0.10°
6.7mm/84°	299/0.28°	373/0.23°	455/0.18°	607/0.14°
8.8mm/84° (1.25” – 2” O.D.)	227/0.37°	284/0.30°	346/0.24°	462/0.18°
14mm/84° (1.25” – 2” O.D.)	143/0.59°	179/0.47°	218/0.39°	290/0.29°

APPENDIX A: EQUATORIAL USE

Celestial Coordinates

Celestial objects are mapped according to a coordinate system on the Celestial Sphere. This is the imaginary sphere surrounding Earth on which all stars appear to be placed. This celestial object mapping system is analogous to the Earth-based coordinate system of latitude and longitude.

The poles of the celestial coordinate system are defined as those two points where the Earth's rotational axis, if extended to infinity, north and south, intersect the celestial sphere. Thus, the North Celestial Pole (1, Fig. 9) is that point in the sky where an extension of the Earth's axis through the North Pole intersects the celestial sphere. This point in the sky is located near the North Star, Polaris.

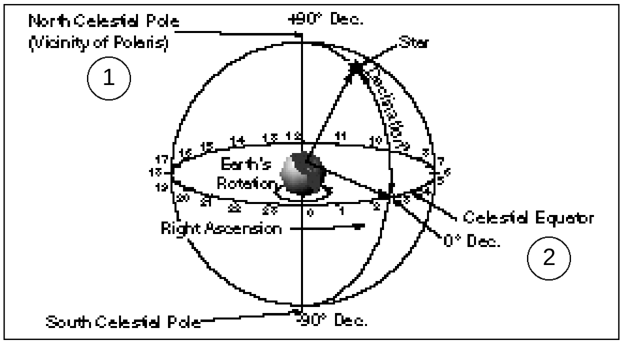


Fig. 9: The Celestial Sphere.

In mapping the surface of the Earth, lines of longitude are drawn between the North and South Poles. Similarly, lines of latitude are drawn in an east-west direction, parallel to the Earth's Equator. The Celestial Equator (2, Fig. 9) is a projection of the Earth's Equator onto the celestial sphere.

As on the surface of the Earth, in mapping the celestial sphere, imaginary lines have been drawn to form a coordinate grid. Object positions on the Earth's surface are specified by their latitude and longitude. You could locate Los Angeles, California, by its latitude (+34°) and longitude (118°).Similarly, you could locate the constellation Ursa Major, which includes the Big Dipper, by its general position on the celestial sphere:

R.A.: 11hr; Dec.: +50°.

- **Right Ascension (R.A.):** R.A. is the celestial analog to Earth longitude. It is measured in time on the 24-hour clock and shown in hours (hr), minutes (min), and seconds (sec) from an arbitrarily defined zero line passing through the constellation Pegasus. R.A. coordinates range from 0hr 0min 0sec to 23hr 59min 59sec. There are 24 primary lines of R.A., located at 15° intervals along the celestial equator. Objects located further east of the prime R.A. grid line (0hr 0min 0sec) carry increasing R.A. coordinate numbers.

- **Declination (Dec.):** Dec. is the celestial analog to Earth latitude. It is measured in degrees, minutes, and seconds (*e.g.,* 15° 27' 33"). Dec. north of the celestial equator is indicated with a plus (+) sign in front of the measurement (*e.g.,* the Dec. of the North Celestial Pole is +90°), with Dec. south of the celestial equator indicated with a minus (–) sign. For example, the Dec. of the South Celestial Pole is –90°. Any point on the celestial equator, which passes through the constellations Orion, Virgo and Aquarius, has a Dec. of zero, shown as 0° 0' 0".

Specifying the position of each celestial object by celestial coordinates of R.A. and Dec. simplifies the task of finding objects (in particular, faint objects). You can dial the R.A. setting circle (9, Fig. 1) and Dec. setting circle (3, Fig. 1) to read the object coordinates and find the object without resorting to visual location techniques. You can use these setting circles to advantage if the you first align the telescope with the North Celestial Pole.

Using the LX200 in POLAR Mode

The Meade 16" LX200 is an ALTAZ telescope, with little need to mount it as an equatorial telescope. The LX200 computer and optional field de-rotator allow tracking, slewing to objects, and long-exposure astrophotography, all in the ALTAZ mode. In the past, these operations required the telescope to be mounted as an equatorial telescope. Almost any astronomy program can now be accomplished with the telescope in the ALTAZ mode.

There is still one application that requires the telescope to be mounted in the POLAR mode. The field de-rotator eliminates field rotation in astrophotographs taken through the telescope. If a secondary instrument, like a Schmidt camera, is mounted to the telescope, astrophotographs taken through this instrument exhibit field rotation. For these applications, the telescope requires an equatorial setup. If you plan on doing this piggy-back type of photography, you need an equatorial permanent pier. Otherwise, mount the telescope on the ALTAZ permanent pier.

Lining up with the Celestial Pole

Objects in the sky appear to revolve around the celestial pole. In fact, they are essentially fixed, and their apparent motion is caused by the Earth's rotation. During any 24-hour period, stars make one complete revolution about the pole, making concentric circles, with the pole at the center. By lining up the telescope's polar axis with the North Celestial Pole (or for observers located in Earth's Southern Hemisphere with the South Celestial Pole (see **MODEFUNCTIONS**, page 17), you can follow, or track, astronomical objects by moving the telescope about one axis, the polar axis.

The 16" LX200 is designed to be mounted to a permanent pier for equatorial use. Since this type of installation is permanent, it is worth the effort to get a very accurate polar alignment of the telescope. This process requires getting a rough polar alignment (described below) and then using the precise polar alignment procedure (see **Precise Polar Alignment**, page 27) for an exact alignment. This process can often span several nights.

Begin polar aligning the telescope as soon as you can see Polaris. Finding Polaris is simple. Many people recognize the Big Dipper constellation, which has two stars that point the way to Polaris (see Fig. 10).

To get a rough polar alignment, follow this procedure:

a. Initiate the polar alignment routine by selecting **POLAR** from the ALIGN menu (when POLAR is selected, a checkmark appears next to POLAR on the display).

b. Begin the alignment procedure by pressing **ENTER**.

c. As prompted, loosen the Dec. lock and rotate the telescope tube in Dec. so that the telescope's Dec. reads 90°. Tighten the Dec. lock. Loosen the R.A. lock, rotate the fork arms to the 00 H.A. position, and tighten the R.A. lock. Press **ENTER**.

   Fig. 5 shows the 00 H.A. position. The 00 line of the R.A. setting circle aligns with the H.A. pointer. The R.A. pointer is almost 2 hours to the right. When the telescope is rotated so that the R.A. pointer aligns with the 00 line/H.A. pointer, this is the 00 H.A. position.

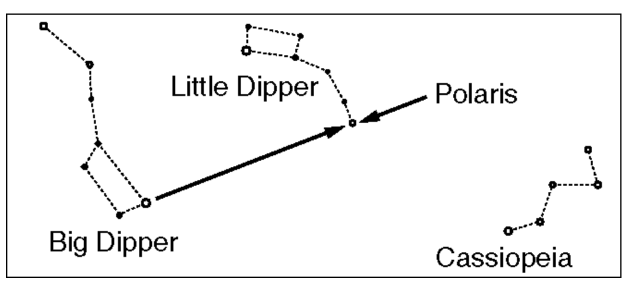


Fig.10: Locating Polaris.

d. The telescope slews to Polaris' position. Using the azimuth and latitude controls on the permanent pier, center Polaris in the field of view. **Do not use the telescope's Dec. or R.A. controls during this step.** Press **ENTER** when Polaris is centered in the eyepiece.

e. The telescope slews to a second alignment star. It prompts you to center this star in the eyepiece. Use the telescope controls to center this star. Press **ENTER**.

At this point, your polar alignment is sufficient to begin the precise polar alignment.

Precise Polar Alignment

The fewer tracking corrections required during a long-exposure photograph, the better. (For our purposes, long-exposure means any photograph requiring 10 minutes or more). In particular, the number of Dec. corrections required depends on the precision of polar alignment.

Precise polar alignment requires a crosshair eyepiece. The Meade illuminated-reticle eyepiece is well suited in this application, but you will want to increase the effective magnification with a 2x or 3x Barlow lens. Use the following drift method:

a. Obtain a rough polar alignment as described earlier. Place the illuminated-reticle eyepiece (or eyepiece/Barlow combination) into the eyepiece holder of the telescope.

b. Point the telescope, with the drive motor running, at a moderately bright star near where the meridian (the North-South line passing through your local zenith) and the celestial equator intersect. For best results, the star should be located within ± 30 minutes in R.A. of the meridian and within ± 5° of the celestial equator. (Pointing the telescope at a star that is straight up, with the Dec. set to 0°, will point the telescope in the right direction.)

c. Note the extent of the star's drift in Dec. (disregard drift in R.A.):

If the star drifts South (or down), the telescope's polar axis is pointing too far East (Fig. 11).

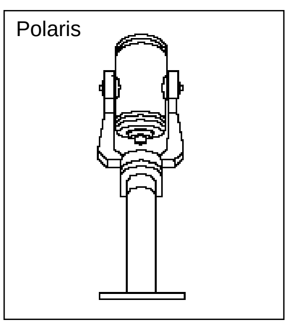


Fig. 11: Mount too far East.

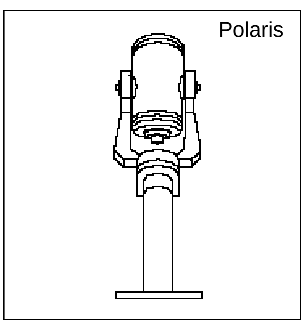


Fig.12: Mount too far West.

If the star drifts North (or up), the telescope's polar axis is pointing too far West (12).

d. Move the pier in azimuth (horizontally) to change the polar alignment. Reposition the telescope's East-West polar axis orientation until the start stops drifting North-South. Track the star for long enough to be certain that its Dec. drift has ceased.

NOTE:Figs. 11, 12, 13, and 14 show the telescope pointed in the 90° position;not the 0° position that is required for drift method alignment.This is done to illustrate the position of the Pole Star relative to the polar axis of the telescope.

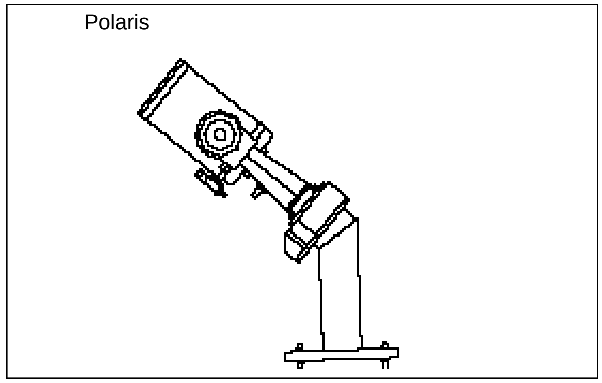


Fig.13: Mount too low.

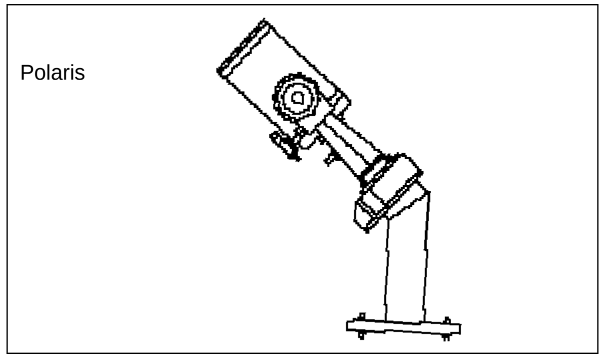


Fig.14: Mount too high.

e. Point the telescope at another moderately bright star near the Eastern horizon, but still near the celestial equator. For best results, the star should be about 20° or 30° above the Eastern horizon and within ± 5° of the celestial equator.

f. Again note the extent of the star's drift in Dec.

If the star drifts South (or down), the telescope's polar axis is pointing too low (Fig. 13).

If the star drifts North (or up), the telescope's polar axis is pointing too high (Fig. 14).

g. Change your pier's latitude angle, based on your observations above. Track the star again long enough to be certain that Dec. drift has ceased.

The above procedure gives very accurate polar alignment. It minimizes the need for tracking corrections during astrophotography.

As an aside procedure, during your first use of the telescope, check the calibration of the Dec. setting circle (3, Fig. 1), located at the top of each side of the fork. After performing the polar alignment procedure, center the star Polaris in the telescope field. Remove the knurled central hub of the Dec. setting circle and *slightly* loosen the two bolts located under the knob. Turn the circle unit until it reads 89.2°, the Dec. of Polaris, and then tighten down the two bolts and replace the knurled knob. Should you wish to use the manual setting circles, the R.A. setting circle (9, Fig. 1) must be calibrated on the R.A. of a star (see **APPENDIX B**) manually every time the telescope is set up. The R.A. setting circle has two sets of numbers: the inner set is for Southern hemisphere use and the other is for Northern hemisphere use.

APPENDIX B:

LX200 ALIGNMENT STAR LIBRARY AND STAR CHARTS:

Alignment Stars

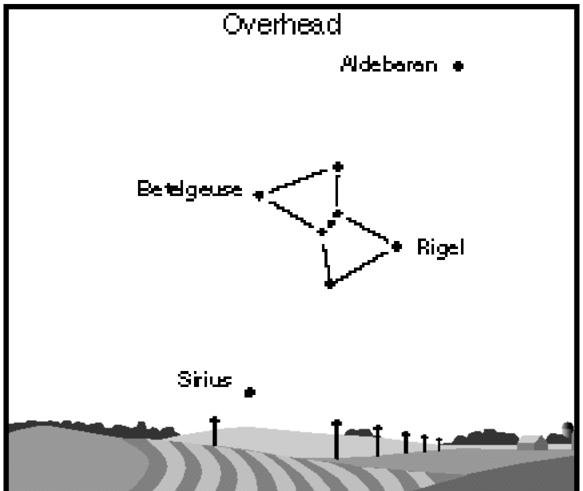
The LX200 utilizes the following 33 bright, well known stars to calibrate the telescope's object library in the ALTAZ and POLAR alignments.

These stars were selected to enable observers, from anywhere in the world and on any given night, to make precision alignments easily and quickly.

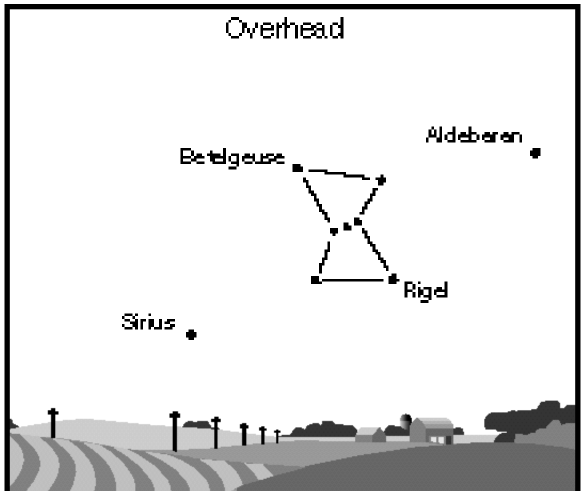
LX200 ALIGNMENT STAR LIBRARY

STAR NAME	STAR #	MAGNITUDE	CONSTELL	R/A	DEC.
ACHERNAR	13	0.5	ERIDANUS	01 37.7	-57 14
ACRUX A	121	1.3	CRUX	12 26.6	-63 06
ALBIREO	223	3.1	CYGNUS	19 30.8	+27 58
ALCAID	140	1.9	URSA MAJOR	13 47.6	+49 19
ALDEBARAN	33	0.9	TAURUS	04 35.9	+16 31
ALNILAM	50	1.7	ORION	05 36.2	-01 12
ALPHARD	95	2.0	HYDRA	09 27.6	-08 39
ALPHEKKA	165	2.2	CORONA BOR.	15 35.5	+26 43
ALTAIR	226	0.8	AQUILA	19 50.8	+08 52
ANTARES	177	0.9	SCORPIUS	16 29.5	-26 26
ARCTURUS	147	0.0	BOOTES	14 15.7	+19 11
BETELGEUSE	56	0.4	ORION	05 55.2	+07 25
BOGARDUS	58	2.6	AURIGA	05 59.8	+37 13
CANOPUS	63	-0.7	CARINA	06 24.0	-52 42
CAPELLA	42	0.1	AURIGA	05 16.6	+46 00
CASTOR A	78	1.9	GEMINI	07 34.6	+31 53
DENEB	232	1.3	CYGNUS	20 41.5	+45 17
DENEBOLA	114	2.1	LEO	11 49.1	+14 34
DIPHDA	8	2.0	CETUS	00 43.6	-17 59
ENIF	238	2.4	PEGASUS	21 44.2	+09 53
FOMALHAUT	247	1.2	PISCES AUST.	22 57.7	-29 38
HADAR	144	0.6	CENTAURUS	14 03.9	-60 24
HAMAL	17	2.0	ARIES	02 07.2	+23 28
MARKAB	249	2.5	PEGASUS	23 04.8	+15 12
MIRA	20	2.1	CETUS	02 19.4	-02 58
POLARIS	19	2.0	URSA MINOR	02 14.7	+89 17
POLLUX	81	1.1	GEMINI	07 45.4	+28 02
PROCYON	80	0.4	CANIS MINOR	07 39.3	+05 14
REGULUS	100	1.4	LEO	10 08.5	+11 58
RIGEL	41	0.1	ORION	05 14.6	-08 12
SIRIUS	67	-1.5	CANIS MAJOR	06 45.2	-16 43
SPICA	138	1.0	VIRGO	13 25.2	-11 10
VEGA	214	0.0	LYRA	18 37.0	+38 47

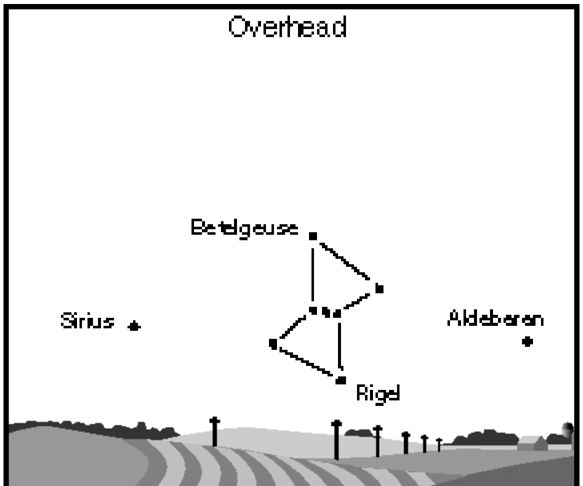
Star Charts
(for Northern Hemisphere Observers)



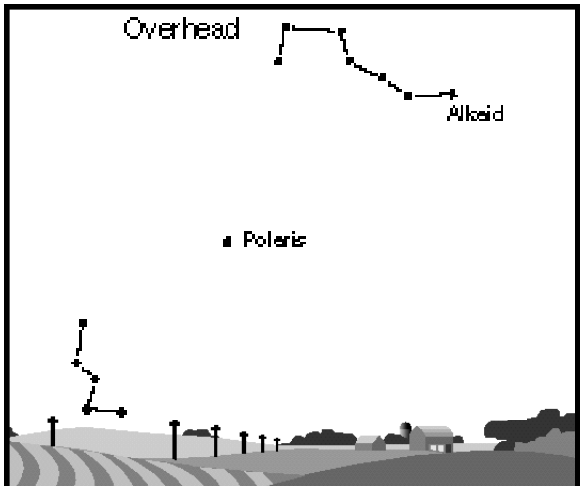
SOUTHEAST
January 7:00 to 9:00



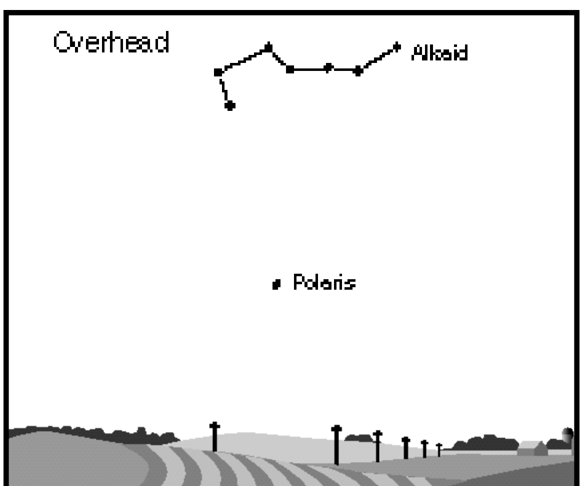
SOUTH
February 7:00 to 9:00



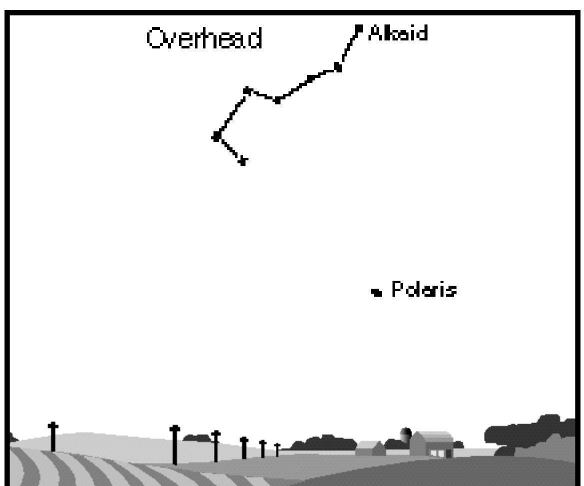
SOUTHWEST
March 7:00 to 9:00



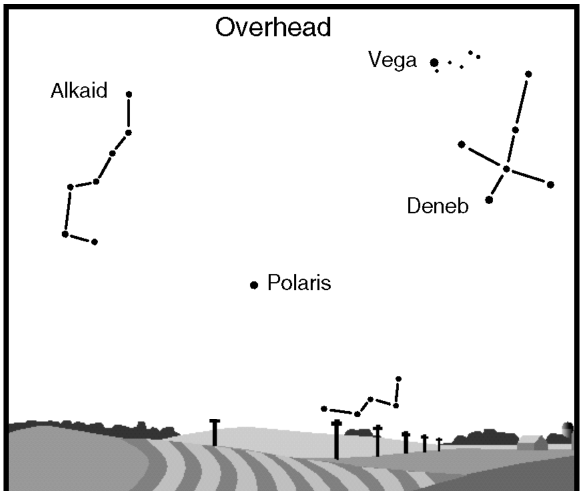
NORTH
April 7:00 to 9:00



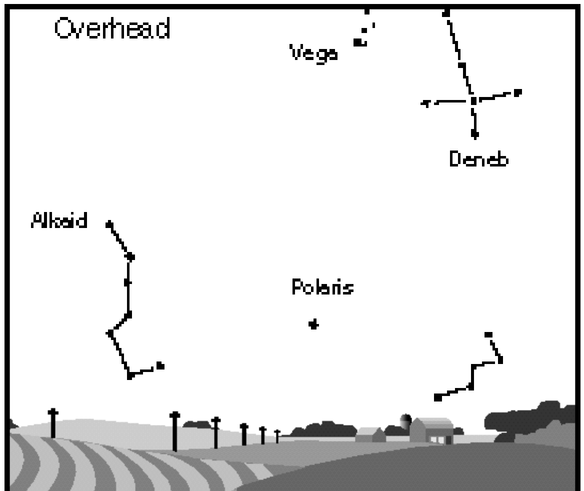
NORTH
May 7:00 to 9:00



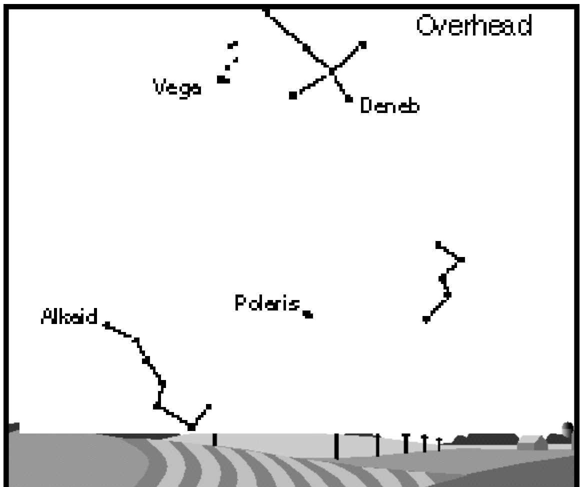
NORTH
June 7:00 to 9:00



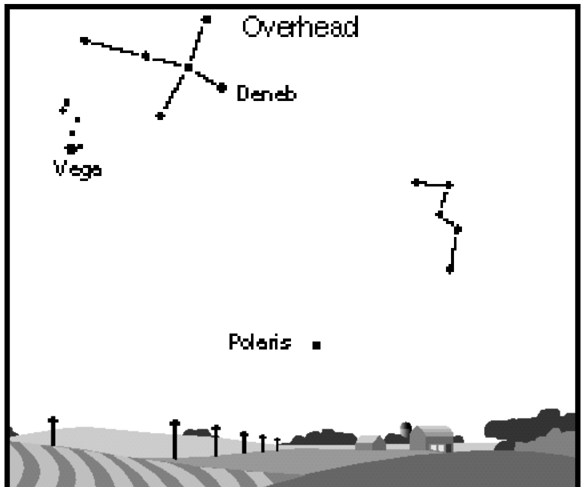
NORTH
July 7:00 to 9:00



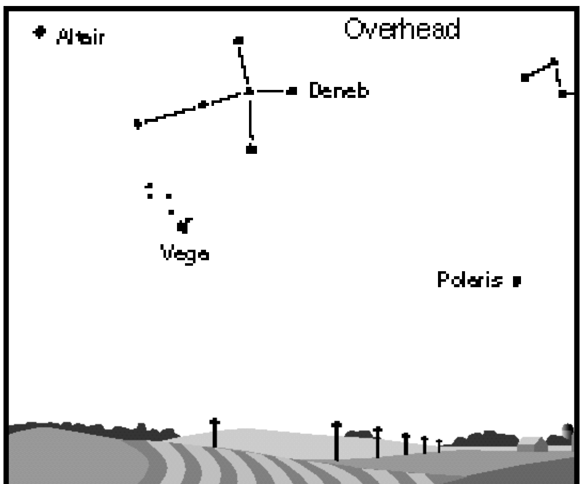
NORTH
August 7:00 to 9:00



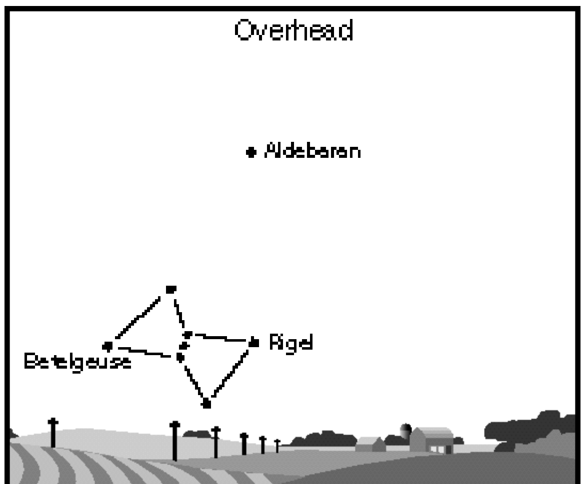
NORTH
September 7:00 to 9:00



NORTH
October 7:00 to 9:00



NORTHWEST
November 7:00 to 9:00



SOUTHEAST
December 7:00 to 9:00

APPENDIX C:
LX200 64,359-OBJECT LIBRARY

The LX200 64,359-object library is a collection of the most studied and wonderful objects in the sky. The library includes:

- 15,928 **SAO** (Smithsonian Astrophysical Observatory) Catalog of Stars: all stars brighter than 7th magnitude.
- 12,921 **UGC** (Uppsala General Catalog) Galaxies: complete catalog.
- 7,840 **NGC** (New General Catalog) objects: complete catalog.
- 5,386 **IC** (Index Catalog) objects: complete catalog.
- 21,815 **GCVS** (General Catalog of Variable Stars) objects: complete catalog.
- 351 alignment stars: LX200 alignment stars.
- 110 **M** (Messier) objects: complete catalog.
- 8 major planets, from Mercury to Pluto.

Page 33 lists 278 of the best NGC objects. These are most of the best objects in the sky; they make good first targets. Page 40 lists the 250 brightest stars and 100 double stars. Page 46 presents the complete Messier list.

Access these databases through the M, STAR, and CNGC keys.

- The M key accesses the M object database.
- The STAR key accesses the SAO, STAR, GCVS, and planet databases.
- The CNGC key accesses the UGC, NGC, and IC databases.

When you press the STAR or CNGC key, the display shows which database is currently active. You can enter the object number for that database or press **ENTER** to bring up the menu to change databases. The LX200 remembers which database you used last.

Smithsonian Astrophysical Observatory (SAO)

The **SAO** catalog is the standard star catalog used in astronomy. It includes all stars brighter than 7th magnitude.

Uppsala General Catalog (UGC)

The UGC of galaxies includes objects as faint as 15th magnitude.

CNGC Catalog

The CNGC is enhanced from the RNGC in many ways. It gives angular sizes in arc-seconds and in a convenient scaled format on the LX200 display. Magnitudes are given to 0.1 magnitude where possible.

The coordinates in the CNGC listing are listed for the year 2000. The LX200 calculates object positions upon power-up to the current date (as shown on the time/date display). This adds accuracy to the LX200.

Objects have been assigned a Visual Quality (VQ) Rating. Many VQs have been obtained by observing the objects. To make the VQs as useful as possible, all observations have been made with the same telescope and eyepiece under substantially identical observing conditions. Only for very small objects was a higher power eyepiece used. Your VQ rating of a particular object will vary, largely due to sky conditions.

If the object has been rated by observation, an upper-case character (ABCDEFG) is used for the VQ on the CNGC listing. If the object has not been observed, the VQ has been estimated by a computer program from the object type, size, and brightness and the VQ is specified in lower-case characters (abcdefg). The VQs for visually-rated objects provide a considerably more consistent guide to observability and appearance than either the computed VQs or an examination of the type, magnitude, and size data.

The following guide to VQs was used in the visual observation process:

SUPER	Very bright object with very interesting shape or structure.
EXCEL	Bright object with very interesting shape or structure. OR Very bright object with moderately interesting shape or structure.
V GOOD	Bright object with moderately interesting shape or structure. OR Very bright object with little or no interesting shape or structure.
GOOD	Easy to see without averted vision with some interesting shape or structure. OR Bright object, but little or no interesting shape or structure.
FAIR	Easy to see without averted vision, but little or no interesting shape or structure.
POOR	Easy to see with averted vision. Often borderline visible without averted vision.
V POOR	A struggle to see with careful use of averted vision.
(none)	Not yet rated AND missing information for computer estimate. OR Could not see despite careful use of averted vision.

All, or nearly all, of the objects in the CNGC are visible with standard instrumentation and observing conditions used to obtain the visual quality ratings. It is a good indication of what to expect with similar equipment by experienced deep-sky observers in excellent conditions. Naturally smaller telescopes and/or less optimal observing conditions will lower the apparent quality of all objects.

The following is a description of the format of the optional **CNGC** listing for each object:

COLUMN	NAME	DESCRIPTION
1	**CNGC #**	CNGC 0001 - CNGC 7840
2	**RA**	Right Ascension
3	**DEC**	Declination
4	**SIZE**	Size of object (arc-seconds)
5	**MAG**	Magnitude (-5.5 through 19.9)
6	**TYPE**	Type of object
7	*****	* object is not in the RNGC
8	**ALT CAT**	Alternate catalog name & number
9	**VQ**	Visual Quality Rating (abcdefg) or (ABCDEFG)
10	**TAGS**	Object Type # (0-F): S = Sky-Cat : T = Tirion
11	**COMMENTS**	Name, comments, other info

The **CNGC** distinguishes the following object types.

TYPE	LEGEND	DESCRIPTION
0	**None**	Unverified Southern Object
1	**OPEN**	Open Cluster
2	**GLOB**	Globular Cluster
3	**DNEB**	Diffuse Nebula
4	**PNEB**	Planetary Nebula (or SN Remnant)
5	**GAL**	Galaxy
6	**OPEN + DNEB**	Open Cluster + Diffuse Nebula
7	**None**	Non-Existent Object
8	**STAR**	Star
9	**MULTI+STAR**	Multiple Star
A	**MULTI+GAL**	Multiple Galaxy (Usually Interacting)
B	**DNEB**	Dark Nebula in front of Diffuse Nebula
C	**GAL+OPEN**	Open Cluster in External Galaxy
D	**GAL+GLOB**	Globular Cluster in External Galaxy
E	**GAL+DNEB**	Diffuse Nebula in External Galaxy
F	**GAL+OPEN+DNEB**	Open Cluster + Diffuse Nebula in Galaxy
S		Object is also listed in the *Sky Catalogue 2000*
T		Object is also listed in the *Tirion Sky Atlas 2000*

About the Index Catalog (IC)

The IC reproduces the complete Index Catalog of a variety of objects that the standard New General Catalog (NGC) missed.

About the General Catalog of Variable Stars (GCVS)

The General Catalog of Variable Stars (GCVS) is shown at the bottom of this page. Variable stars from the GCVS are entered using a six digit number. The first two digits refer to the constellation where the variable star is located. These digits are listed in the table below.

The next four digits are assigned sequentially within each constellation according to the standard sequence of variable-star designations (R, S, ...).Therefore, the first star in the constellation of Virgo would be entered as: 860001.

About the Star Catalog

The STAR catalog contains the 250 brightest stars (STAR 1 through STAR 250), 100 interesting double stars (STAR 251 through STAR 350), plus Sigma Octantis, the southern Pole Star (STAR 351).

About the Messier (M) Catalog

The M catalog has been the benchmark deep-sky catalog for years. Recently expanded to 110 objects, the M catalog contains most of the best deep-sky objects.

The Planet Catalog

The LX200 calculates the orbital positions of the eight major planets for the current calendar date. To access a planet, use the STAR key and enter the appropriate number as indicated below *(903 is the Moon)*:

OBJECT LIBRARY PLANET LEGEND			
PLANET	**STAR #**	**PLANET**	**STAR#**
MERCURY	901	SATURN	906
VENUS	902	URANUS	907
MARS	904	NEPTUNE	908
JUPITER	905	PLUTO	909

General Catalog of Variable Stars (GCVS)

Code	Const	Code	Const	Code	Const	Code	Const
01	AND	23	CIR	45	LAC	67	PSA
02	ANT	24	COL	46	LEO	68	PUP
03	APS	25	COM	47	LMI	69	PYX
04	AQR	26	CRA	48	LEP	70	RET
05	AQL	27	CRB	49	LIB	71	SGE
06	ARA	28	CRV	50	LUP	72	SGR
07	ARI	29	CRT	51	LYN	73	SCO
08	AUR	30	CRU	52	LYR	74	SCL
09	BOO	31	CYG	53	MEN	75	SCT
10	CAE	32	DEL	54	MIC	76	SER
11	CAM	33	DOR	55	MON	77	SEX
12	CNC	34	DRA	56	MUS	78	TAU
13	CVN	35	EQU	57	NOR	79	TEL
14	CMA	36	ERI	58	OCT	80	TRI
15	CMI	37	FOR	59	OPH	81	TRA
16	CAP	38	GEM	60	ORI	82	TUC
17	CAR	39	GRU	61	PAV	83	UMA
18	CAS	40	HER	62	PEG	84	UMI
19	CEN	41	HOR	63	PER	85	VEL
20	CEP	42	HYA	64	PHE	86	VIR
21	CET	43	HYI	65	PIC	87	VOL
22	CHA	44	IND	66	PSC	88	VUL

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
0045	00 14.0	-23 10	486	10.4	GALAXY S- IV-V	UGC A4	c 5 ST	8.1x5.8
0055	00 15.1	-39 13	1944	8.2	GALAXY SBm: PEC EMISSION		b 5 ST	32.4x6.5
0104	00 24.1	-72 04	1854	4.0v	GLOB CLUS sp=G3	47 Tuc	B 2 ST	47 Tuc 16kly
0129	00 29.9	+60 14	1260	6.5v	OPEN CLUS		c 1 ST	
0134	00 30.4	-33 15	486	10.1	GALAXY S(B)b+		c 5 ST	8.1x2.6
0188	00 44.3	+85 21	840	8.1v	OPEN CLUS sp=F2		c 1 ST	Oldest Open Cluster 5kly
0205	00 40.4	+41 42	1044	8.0	GALAXY E6:	UGC 426	C 5 ST	M110 Comp of M31 17.4x9.8
0221	00 42.8	+40 53	456	8.2	GALAXY E2	UGC 452	C 5 ST	M32 Comp of M31 7.6x5.8
0224	00 42.8	+41 17	10680	3.5	GALAXY Sb I-II	UGC 454	B 5 ST	M31 Andromeda Gal 178x63
0225	00 43.5	+61 48	720	7.0	OPEN CLUS		c 1 ST	
0247	00 47.1	-20 44	1200	8.9	GALAXY S- IV	UGC A11	b 5 ST	20.0x7.4
0253	00 47.5	-25 17	1506	7.1	GALAXY Scp	UGC A13	C 5 ST	25.1x7.4
0288	00 52.6	-26 36	828	8.1v	GLOB CLUS		b 2 ST	
0300	00 55.0	-37 42	1200	8.7	GALAXY Sd III-IV		b 5 ST	20.0x14.8
0362	01 02.4	-70 51	774	6.6v	GLOB CLUS		b 2 ST	
0370	01 04.8	+02 07	720	9.3	GALAXY Ir+ V	* IC 1613	c 5 S	12.0x11.2
0411	01 07.9	-71 46	750	11.0	GLOB CLUS IN SMC		c D	
0458	01 14.9	-71 32	750	10.5	GLOB CLUS IN SMC		c D	
0581	01 33.3	+60 43	360	7.4v	OPEN CLUS	CNGC 0581	D 1 ST	M103
0598	01 33.9	+30 40	3720	5.7	GALAXY Sc II-III	UGC 1117	C 5 ST	M33 Triangulum Gal 62x39
0628	01 36.7	+15 47	612	9.2	GALAXY Sc I	UGC 1149	D 5 ST	M74 10.2x9.5
0650	01 42.0	+51 34	290	12.2	PLAN NEB PART OF 0651	CNGC 0650	C 4 ST	M76 Little Dumbbell Nebula
0651	01 42.0	+51 34	290	12.2	PLAN NEB PART OF 0650		C 4 ST	Little Dumbbell Nebula
0654	01 43.9	+61 53	300	6.5v	OPEN CLUS		c 1 ST	
0660	01 43.0	+13 38	546	10.8	GALAXY SBap	UGC 1201	c 5 S	9.1x4.1
0744	01 58.6	+55 29	660	7.9v	OPEN CLUS		c 1 ST	
0752	01 57.8	+37 41	3000	5.7v	OPEN CLUS sp=A5		c 1 ST	1200ly
0869	02 19.1	+57 09	1800	4.3p	OPEN CLUS sp=B1		A 1 ST	Double Cluster h Per 7kly
0884	02 22.5	+57 07	1800	4.4p	OPEN CLUS sp=B0		A 1 ST	Double Cluster x Per 8kly
0925	02 27.3	+33 35	588	10.0	GALAXY S(B)c II-III	UGC 1913	c 5 ST	9.8x6.0
0956	02 32.4	+44 38	480	8.9p	OPEN CLUS		c 1 S	
0957	02 33.6	+57 31	660	7.6v	OPEN CLUS		c 1 ST	
1023	02 40.5	+39 04	522	9.5	GALAXY E7p	UGC 2154	C 5 ST	8.7x3.3
1025	02 39.9	-34 32	1200	9.0p	GALAXY dE3	*	b 5 S	20.0x13.8
1027	02 42.7	+61 33	1200	6.7v	OPEN CLUS		c 1 ST	
1039	02 42.0	+42 47	2100	5.2v	OPEN CLUS	CNGC 1039	C 1 ST	M34
1068	02 42.7	-00 01	414	8.8	GALAXY Sbp SEYFERT	UGC 2188	D 5 ST	M77 6.9x5.9 Seyfert Galaxy
1097	02 46.5	-30 16	558	9.3	GALAXY S(B)b I-II 2-SYS	UGC A41	c A ST	9.3x6.6 2-SYS + E5
1112	02 51.2	+60 27	720	6.5v	OPEN CLUS + DNEB IV 3 p n	* IC 1848	c 6 ST	
1232	03 09.7	-20 34	468	9.9	GALAXY Sc I 2-SYS		C A ST	7.8x6.9 2-SYS +SBm
1245	03 14.6	+47 14	600	8.4v	OPEN CLUS		c 1 ST	
1261	03 12.3	-55 14	414	8.4v	GLOB CLUS		c 2 ST	
1291	03 17.3	-41 05	630	8.5	GALAXY SBa		b 5 ST	10.5x9.1
1313	03 10.0	-66 41	510	9.4	GALAXY SBd		c 5 ST	8.5x6.6
1316	03 22.6	-37 14	426	8.9	GALAXY S(B)0p 3-SYS		c A ST	7.1x5.5 3-SYS
1342	03 31.6	+37 20	840	6.7v	OPEN CLUS		c 1 ST	
1360	03 33.4	-25 51	390	9.0p	PLAN NEB		c 4 ST	
1365	03 33.7	-36 08	588	9.5	GALAXY SBb I-II		c 5 S	9.8x5.5
1432	03 46.0	+24 09	6600	3.4	OPEN CLUS + RNEB		c 6 S	Pleiades M45 Blue Nebula
1444	03 49.4	+52 39	240	6.6v	OPEN CLUS		c 1 ST	
1454	03 46.7	+68 07	1068	9.1	GALAXY S(B)c I-II	* IC 342	b 5 ST	17.8x17.4 UGC 2847
1457	03 47.1	+24 07	7200	1.6	OPEN CLUS + RNEB sp=B6	* CNGC 1457	c 6 ST	M45 Pleiades 410ly
1502	04 07.4	+62 19	480	5.7v	OPEN CLUS		c 1 ST	
1513	04 10.1	+49 31	540	8.4v	OPEN CLUS		c 1 ST	
1528	04 15.4	+51 15	1440	6.4v	OPEN CLUS		c 1 ST	
1545	04 20.9	+50 15	1080	6.2v	OPEN CLUS		c 1 ST	
1582	04 32.2	+43 52	2220	7.0p	OPEN CLUS		c 1 S	
1647	04 46.2	+19 05	2700	6.4v	OPEN CLUS		c 1 ST	
1662	04 48.5	+10 56	1200	6.4v	OPEN CLUS		c 1 S	
1664	04 51.0	+43 42	1080	7.6v	OPEN CLUS		c 1 ST	

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
1746	05 03.6	+23 49	2520	6.1p	OPEN CLUS		c 1 ST	
1763	04 56.8	-66 24	1500	8.3	OPEN CLUS + ENEB IN LMC		B F S	
1807	05 10.7	+16 32	1020	7.0v	OPEN CLUS		c 1 ST	
1817	05 12.1	+16 42	960	7.7v	OPEN CLUS		c 1 ST	
1820	05 03.8	-67 17	410	9.0	OPEN CLUS IN LMC		c C	
1851	05 14.0	-40 02	660	7.3v	GLOB CLUS sp=F7		b 2 ST	46kly X-Ray Source
1857	05 20.1	+39 21	360	7.0v	OPEN CLUS		c 1 ST	
1893	05 22.7	+33 24	660	7.5v	OPEN CLUS + ENEB HII		c 6 ST	
1904	05 24.2	-24 31	522	8.0v	GLOB CLUS	CNGC 1904	D 2 ST	M79
1912	05 28.7	+35 51	1260	6.4v	OPEN CLUS sp=B5	CNGC 1912	C 1 ST	M38 4600ly
1952	05 34.5	+22 01	360	8.4	PLAN NEB EMIS SN REM	CNGC 1952	B 4 ST	M1 Crab Nebula 4kly
1960	05 36.2	+34 08	720	6.0v	OPEN CLUS	CNGC 1960	C 1 ST	M36
1966	05 26.5	-68 47	780	8.5	OPEN CLUS + DNEB IN LMC		b F S	
1975	05 35.4	-04 41	600	8.8	DIFF RNEB		b 3 ST	Blue
1976	05 35.3	-05 23	3960	3.9	DIFF RNEB + ENEB	CNGC 1976	A 3 ST	M42 Orion Nebula Blue+Red
1980	05 35.2	-05 55	840	2.5	OPEN CLUS + ENEB sp=O5		c 6 ST	Trapezium in M42 1300ly
1981	05 35.3	-04 26	1500	4.6v	OPEN CLUS		b 1 ST	
1982	05 35.5	-05 16	1200	5.8	DIFF RNEB + ENEB	CNGC 1982	C 3 ST	M43 Orion Nebula Extension
1999	05 36.5	-06 43	960	9.5	DIFF RNEB		C 3 ST	
2024	05 42.0	-01 50	1800	8.8	DIFF ENEB HII		b 3 ST	Red Near Zeta Ori
2068	05 46.8	+00 03	480	11.3	DIFF RNEB	CNGC 2068	C 3 ST	M78 Blue 1500ly
2070	05 38.5	-69 05	300	8.3v	OPEN CLUS + ENEB IN LMC		B F ST	Tarantula Nebula Very Red
2074	05 39.0	-69 30	960	8.5	OPEN CLUS + ENEB IN LMC		b F S	30 Dor Nebula (part)
2099	05 52.4	+32 33	1440	5.6v	OPEN CLUS sp=B8	CNGC 2099	C 1 ST	M37 4200ly
2129	06 01.1	+23 18	420	6.7v	OPEN CLUS		c 1 ST	
2168	06 08.9	+24 21	1680	5.1v	OPEN CLUS sp=B5	CNGC 2168	C 1 ST	M35 2800ly
2169	06 08.4	+13 58	420	5.9v	OPEN CLUS		c 1 ST	
2175	06 09.8	+20 19	1080	6.8v	OPEN CLUS + ENEB		c 6 ST	Red Faint/Low Contrast
2194	06 13.8	+12 49	600	8.5v	OPEN CLUS		c 1 ST	
2204	06 15.7	-18 39	780	8.6v	OPEN CLUS		c 1 ST	
2215	06 20.8	-07 17	660	8.4v	OPEN CLUS		c 1 ST	
2232	06 26.8	-04 44	1800	3.9v	OPEN CLUS sp=B1		b 1 S	1600ly
2237	06 30.3	+05 03	4800	7.4	OPEN CLUS + ENEB		c 6 ST	Cluster in Rosette Nebula
2244	06 32.3	+04 52	1440	4.8v	OPEN CLUS + ENEB sp=O5		b 6 ST	Rosette Nebula 5300ly
2250	06 32.8	-05 02	480	8.9p	OPEN CLUS		c 1 S	
2251	06 34.8	+08 22	600	7.3v	OPEN CLUS		c 1 ST	
2252	06 35.0	+05 23	1200	7.7p	OPEN CLUS		c 1 S	
2264	06 41.2	+09 53	1200	3.9v	OPEN CLUS + ENEB sp=O8		b 6 ST	S Mon + Cone Nebula 2400ly
2281	06 49.4	+41 04	900	5.4v	OPEN CLUS		c 1 ST	
2286	06 47.7	-03 10	900	7.5v	OPEN CLUS		c 1 ST	
2287	06 47.1	-20 45	2280	4.5v	OPEN CLUS sp=B4	CNGC 2287	C 1 ST	M41 2200ly
2301	06 51.8	+00 28	720	6.0v	OPEN CLUS		c 1 ST	
2323	07 02.9	-08 20	960	5.9v	OPEN CLUS	CNGC 2323	D 1 ST	M50
2324	07 04.2	+01 04	480	8.4v	OPEN CLUS		c 1 ST	
2331	07 07.3	+27 21	1080	8.5p	OPEN CLUS		c 1 S	
2335	07 06.6	-10 05	720	7.2v	OPEN CLUS		c 1 ST	
2343	07 08.3	-10 40	420	6.7v	OPEN CLUS		c 1 S	
2345	07 08.4	-13 10	720	7.7v	OPEN CLUS		c 1 ST	
2353	07 14.7	-10 17	1200	7.1v	OPEN CLUS		c 1 ST	
2354	07 14.2	-25 43	1200	6.5v	OPEN CLUS		c 1 ST	
2360	07 17.7	-15 38	780	7.2v	OPEN CLUS		c 1 ST	
2362	07 18.7	-24 58	480	4.1v	OPEN CLUS + ENEB sp=O9		c 6 ST	Open Clus = 20' Very Red
2374	07 24.1	-13 15	1140	8.0v	OPEN CLUS		c 1 ST	
2395	07 27.1	+13 35	720	8.0v	OPEN CLUS		c 1 ST	
2396	07 28.2	-11 44	600	7.4p	OPEN CLUS		c 1 S	
2403	07 36.9	+65 36	1068	8.4	GALAXY Sc III	UGC 3918	b 5 ST	17.8x11.0
2420	07 38.4	+21 34	600	8.3v	OPEN CLUS		c 1 ST	
2421	07 36.3	-20 37	600	8.3v	OPEN CLUS		c 1 ST	
2422	07 36.6	-14 29	1800	4.4v	OPEN CLUS sp=B3	CNGC 2422	D 1 ST	M47 1600ly
2423	07 37.2	-13 52	1140	6.7v	OPEN CLUS		c 1 ST	

CNGC Catalog (continued)

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
2437	07 41.9	-14 49	1620	6.1v	OPEN CLUS sp=B8	CNGC 2437	C 1 ST	M46 5400ly (+CNGC 2438 PN)
2447	07 44.6	-23 52	1320	6.2v	OPEN CLUS + DNEB	CNGC 2447	D 6 ST	M93 Includes dark nebula
2451	07 45.4	-37 58	2700	2.8v	OPEN CLUS sp=B5		C 1 ST	1000ly
2467	07 52.5	-26 24	480	7.2p	OPEN CLUS + ENEB		C 6 ST	Open Cluster + Red Nebula
2477	07 52.3	-38 33	1620	5.8v	OPEN CLUS		C 1 ST	
2516	07 58.2	-60 52	1800	3.8v	OPEN CLUS sp=B8		C 1 ST	1200ly
2547	08 10.7	-49 16	1200	4.7v	OPEN CLUS		C 1 ST	
2548	08 13.7	-05 47	3240	5.8v	OPEN CLUS	CNGC 2548	D 1 ST	M48
2631	08 40.2	-53 04	3000	2.5v	OPEN CLUS II 3 p	* IC 2391	C 1 ST	
2632	08 40.1	+19 59	5700	3.1v	OPEN CLUS sp=A0	CNGC 2632	C 1 ST	M44 Praesepe/Beehive 590ly
2682	08 51.1	+11 49	1800	6.9v	OPEN CLUS sp=F2	CNGC 2682	D 1 ST	M67 Very old 2700ly
2808	09 11.9	-64 51	828	6.3v	GLOB CLUS sp=F8		C 2 ST	30kly
2841	09 22.1	+50 58	486	9.3	GALAXY Sb- I	UGC 4966	C 5 ST	8.1x3.8
2903	09 32.1	+21 30	756	8.9	GALAXY Sb+ I-II	UGC 5079	b 5 ST	12.6x6.6
2997	09 45.7	-31 12	486	10.6	GALAXY Sc I	UGC A181	C 5 ST	8.1x6.5
3031	09 55.7	+69 04	1542	6.9	GALAXY Sb I-II	CNGC 3031	C 5 ST	M81 25.7x14.1 Near M82
3034	09 55.9	+69 41	672	8.4	GALAXY P EDGE-ON	UGC 5322	C 5 ST	M82 11.2x4.6 Exploding
3109	10 03.1	-26 10	870	10.4	GALAXY Ir+ IV-V	UGC A194	c 5 ST	14.5x3.5
3114	10 02.7	-60 08	2100	4.2v	OPEN CLUS sp=B5		b 1 ST	2800ly
3115	10 05.3	-07 43	498	9.2	GALAXY E6		c 5 ST	8.3x3.2
3157	10 08.4	+12 18	642	9.9v	GALAXY dE3	* UGC 5470	c 5 S	10.7x8.3
3198	10 20.0	+45 33	498	10.4	GALAXY Sc II	UGC 72	c 5 ST	8.3x3.7
3201	10 17.5	-46 24	1092	6.8v	GLOB CLUS		b 2 ST	
3228	10 21.7	-51 43	1080	6.0v	OPEN CLUSTER		c 1 ST	
3231	10 27.4	-57 38	480	4.3v	OPEN CLUS + DNEB I 3 m n	* IC 2581	c 6 ST	
3234	10 28.5	+68 26	738	10.6	GALAXY S+ IV-V	* IC 2574	c 5 ST	12.3x5.9 UGC 5666
3242	10 24.8	-18 38	1250	8.6p	PLAN NEB		C 4 ST	Ghost of Jupiter
3293	10 35.9	-58 14	360	4.7v	OPEN CLUS + ENEB		c 6 ST	
3324	10 37.5	-58 38	360	6.7v	DIFF ENEB + RNEB + OPEN		c 6 ST	9kly
3328	10 43.2	-64 24	3000	1.9v	OPEN CLUS II 3 m	* IC 2602	b 1 ST	
3351	10 43.9	+11 42	444	9.7	GALAXY S(B)b II	UGC 5850	C 5 ST	M95 7.4x5.1 Near M96
3368	10 46.7	+11 49	426	9.2	GALAXY Sbp	UGC 5882	C 5 ST	M96 7.1x5.1 Near M95
3372	10 45.1	-59 41	7200	5.3	DIFF ENEB + OPEN CLUS HII		A 6 ST	Eta Carina Nebula Red 9kly
3379	10 47.8	+12 35	270	9.3	GALAXY E1 2-SYS	UGC 5902	C A ST	M105 4.5x4.0
3496	10 59.8	-60 20	540	8.2v	OPEN CLUS		c 1 S	
3521	11 05.9	-00 02	570	8.9	GALAXY Sb+ II	UGC 6150	b 5 ST	9.5x5.0
3532	11 06.5	-58 40	3300	3.0v	OPEN CLUS sp=B8		b 1 ST	1400ly
3556	11 11.6	+55 41	498	10.1	GALAXY Sc NEAR EDGE-ON	UGC 6225	C 5 ST	M108 8.3x2.5 Near M97
3572	11 10.5	-60 14	420	6.6v	OPEN CLUS + ENEB		c 6 ST	
3587	11 14.8	+55 02	194	12.0p	PLAN NEB	CNGC 3587	C 4 ST	M97 Owl Nebula 12kly
3604	11 17.9	-62 42	720	8.2p	OPEN CLUS II 3 m	* IC 2714	c 1 ST	
3621	11 18.3	-32 49	600	9.9	GALAXY Sc III-IV	UGC A232	c 5 ST	10.0x6.5
3623	11 18.9	+13 05	600	9.3	GALAXY Sb II:	UGC 6328	C 5 ST	M65 10.0x3.3 Near M66
3627	11 20.2	+12 59	522	9.0	GALAXY Sb+ II:	UGC 6346	C 5 ST	M66 8.7x4.4 Near M65
3628	11 20.3	+13 35	888	9.5	GALAXY Sb NEAR EDGE-ON	UGC 6350	C 5 ST	14.8x3.6
3680	11 25.7	-43 15	720	7.6v	OPEN CLUS		c 1 ST	
3709	11 36.6	-63 02	900	4.5v	OPEN CLUS II 1 p n	* IC 2944	b 1 ST	
3718	11 32.6	+53 04	522	10.5	GALAXY SBap	UGC 624	c 5 ST	8.7x4.5
3766	11 36.2	-61 37	720	5.3v	OPEN CLUS sp=B1		c 1 ST	5800ly
3992	11 57.6	+53 22	456	9.8	GALAXY S(B)b+ I	UGC 6937	D 5 ST	M109 7.6x4.9
4052	12 01.9	-63 12	480	8.8p	OPEN CLUS		c 1 ST	
4111	12 07.1	+43 04	288	10.8	GALAXY S0:	UGC 7103	C 5 ST	4.8x1.1
4192	12 13.9	+14 54	570	10.1	GALAXY Sb I-II: 3-SYS	UGC 7231	D A ST	M98 9.5x3.2
4216	12 15.9	+13 08	498	10.0	GALAXY Sb II	UGC 7284	c 5 ST	8.3x2.2 Near Edge-On
4236	12 16.7	+69 28	1116	9.7	GALAXY SB+ IV	UGC 7306	b 5 ST	18.6x6.9
4244	12 17.6	+37 48	972	10.2	GALAXY S- IV: EDGE-ON	UGC 7322	b 5 ST	16.2x2.5
4254	12 18.9	+14 25	324	9.8	GALAXY Sc I NEAR FACE-ON	UGC 7345	D 5 ST	M99 5.4x4.8
4258	12 19.0	+47 18	1092	8.3	GALAXY Sb+p	UGC 7353	C 5 ST	M106 18.2x7.9
4303	12 22.0	+04 28	360	9.7	GALAXY Sc I 2-SYS	UGC 7420	D A ST	M61 6.0x5.5 Face-On
4321	12 23.0	+15 49	414	9.4	GALAXY Sc I FACE-ON	UGC 7450	D 5 ST	M100 6.9x6.2 Brite Nucleus

CNGC Catalog (continued)

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
4349	12 24.2	-61 54	960	7.4v	OPEN CLUS		c 1 ST	
4374	12 25.1	+12 53	300	9.3	GALAXY E1	UGC 7494	C 5 ST	M84 5.0x4.4 Near M86
4382	12 25.5	+18 11	426	9.2	GALAXY Ep 2-SYS	UGC 7508	C A ST	M85 7.1x5.2
4395	12 25.8	+33 32	774	10.2	GALAXY S+ IV-V	UGC 7524	c 5 S	12.9x11.0
4406	12 26.3	+12 56	444	9.2	GALAXY E3	UGC 7532	C 5 ST	M86 7.4x5.5
4438	12 27.8	+13 00	558	10.1	GALAXY Sap	UGC 7574	c 5 ST	9.3x3.9
4472	12 29.8	+08 00	534	8.4	GALAXY E4	UGC 7629	C 5 ST	M49 8.9x7.4
4486	12 30.9	+12 23	432	8.6	GALAXY E1 + E0 2-SYS	UGC 7654	D A ST	M87 7.2x6.8 + CNGC 4471
4501	12 32.1	+14 25	414	9.5	GALAXY Sb+ I MULTI-ARM	UGC 7675	D 5 ST	M88 6.9x3.9
4517	12 32.8	+00 06	612	10.5	GALAXY Sc 2-SYS	UGC 7694	c A ST	10.2x1.9 Near Edge-On
4548	12 35.5	+14 29	324	10.2	GALAXY SBb + Sc 2-SYS	UGC 7753	D A ST	M91 5.4x4.4 Near CNGC 4571
4552	12 35.7	+12 33	252	9.8	GALAXY E0	UGC 7760	D 5 ST	M89 4.2x4.2
4559	12 36.0	+27 57	630	9.9	GALAXY Sc II-III 3-SYS	UGC 7766	C A ST	10.5x4.9 Coarse Structure
4565	12 36.4	+25 59	972	9.6	GALAXY Sb I: + 3-SYS FNT	UGC 7772	B A ST	M40 16.2x2.8 Edge-On Lane
4569	12 36.9	+13 09	570	9.5	GALAXY Sb+	UGC 7786	C 5 ST	M90 9.5x4.7
4579	12 37.8	+11 49	324	9.8	GALAXY Sb	UGC 7796	C 5 ST	M58 5.4x4.4 Near CNGC 4621
4590	12 39.4	-26 46	720	8.2v	GLOB CLUS	CNGC 4590	D 2 ST	M68
4594	12 39.9	-11 38	534	8.3	GALAXY Sb-	CNGC 4594	C 5 ST	M104 8.9x4.1 “Sombrero”
4605	12 40.0	+61 36	330	11.0	GALAXY SBcp Edge-On	UGC 7831	C 5 ST	5.5x2.3 Edge-On
4609	12 42.4	-62 59	300	6.9v	OPEN CLUS		c 1 ST	
4621	12 42.1	+11 38	306	9.8	GALAXY E3	UGC 7858	D 5 ST	M59 5.1x3.4 Near CNGC 4579
4631	12 42.1	+32 32	906	9.3	GALAXY Sc III Edge-On	UGC 7865	B 5 ST	15.1x3.3 Edge-On
4649	12 43.7	+11 33	432	8.8	GALAXY E1	UGC 7898	D 5 ST	M60 7.2x6.2 Near CNGC 4621
4656	12 43.9	+32 10	828	10.4	GALAXY Sc IV + Ir+ 2-SYS	UGC 7907	C A ST	13.8x3.3 Near CNGC 4631
4725	12 50.5	+25 33	660	9.2	GALAXY S(B)b I	UGC 7989	C 5 ST	11.0x7.9
4736	12 50.9	+41 08	660	8.2	GALAXY Sb-p II:	UGC 7996	C 5 ST	M94 11.0x9.1
4755	12 53.6	-60 21	600	4.2v	OPEN CLUS sp=B3		c 1 ST	Jewel Box 6800ly
4762	12 53.0	+11 14	522	10.2	GALAXY SB0	UGC 8016	c 5 ST	8.7x1.6
4826	12 56.7	+21 41	558	8.5	GALAXY Sb-	UGC 8062	C 5 ST	M64 9.3x5.4 Black Eye Gal
4833	12 59.4	-70 52	810	7.4v	GLOB CLUS		b 2 ST	
4852	13 00.1	-59 36	660	8.9p	OPEN CLUS		c 1 ST	
4945	13 05.3	-49 29	1200	9.5	GALAXY SBc: 2-SYS		b A ST	20.0x4.
5024	13 13.0	+18 10	756	7.7v	GLOB CLUS	CNGC 5024	D 2 ST	M53
5033	13 13.5	+36 36	630	10.1	GALAXY Sb+ I-II:	UGC 8307	c 5 ST	10.5x5.6
5053	13 16.4	+17 40	630	9.8v	GLOB CLUS		c 2 ST	
5055	13 15.8	+42 02	738	8.6	GALAXY Sb+ II	UGC 8334	C 5 ST	M63 12.3x7.6 Sunflower Gal
5102	13 21.9	-36 39	558	10.0	GALAXY S0		c 5 ST	9.3x3.5
5128	13 25.3	-43 01	1092	7.0	GALAXY S0p		B 5 ST	18.2x14.5 Centaurus A X-Ray
5138	13 27.3	-59 01	480	7.6v	OPEN CLUS		c 1 ST	
5139	13 26.8	-47 29	2178	3.7v	GLOB CLUS sp=F7	Omega Cen	A 2 ST	Omega Centauri 17kly
5194	13 30.0	+47 11	660	8.4	GALAXY Sc I 2-SYS FACE	UGC 8493	B A ST	M51 11.0x7.8 Whirlpool Gal
5236	13 37.1	-29 51	672	8.2	GALAXY Sc I-II FACE-ON	CNGC 5236	B 5 ST	M83 11.2x10.2
5272	13 42.3	+28 23	972	6.4v	GLOB CLUS sp=F7	CNGC 5272	B 2 ST	M3 35kly
5281	13 46.7	-62 54	300	5.9v	OPEN CLUS		c 1 ST	
5286	13 46.2	-51 22	546	7.6v	GLOB CLUS		b 2 ST	
5316	13 54.0	-61 52	840	6.0v	OPEN CLUS		c 1 ST	
5457	14 03.3	+54 21	1614	7.7	GALAXY Sc I FACE-ON	UGC 8981	C 5 S	M101 26.9x26.3 Pinwheel
5460	14 07.7	-48 19	1500	5.6v	OPEN CLUS		c 1 ST	
5474	14 05.1	+53 40	270	10.9	GALAXY Sc	UGC 9013	C 5 ST	4.5x4.2
5617	14 29.8	-60 44	600	6.3v	OPEN CLUS		c 1 ST	
5662	14 35.1	-56 34	720	5.5v	OPEN CLUS		c 1 ST	
5746	14 45.0	+01 57	474	10.6	GALAXY Sb EDGE-ON	UGC 9499	C 5 ST	7.9x1.7
5749	14 48.9	-54 32	480	8.8p	OPEN CLUS		c 1 ST	
5822	15 05.3	-54 21	2400	6.5p	OPEN CLUS		c 1 ST	
5823	15 05.7	-55 36	600	7.9v	OPEN CLUS		c 1 ST	
5824	15 04.0	-33 05	372	9.0v	GLOB CLUS		c 2 ST	
5897	15 17.4	-21 00	756	8.6v	GLOB CLUS		b 2 ST	
5904	15 18.6	+02 05	1044	5.8v	GLOB CLUS sp=F6	CNGC 5904	B 2 ST	M5 26kly
5907	15 15.9	+56 19	738	10.4	GALAXY Sb+ II:	UGC 9801	C 5 ST	12.3x1.8
5925	15 27.7	-54 32	900	8.4p	OPEN CLUS		c 1 ST	

CNGC Catalog (continued)

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
5927	15 28.0	-50 40	720	8.3v	GLOB CLUS		b 2 ST	
5986	15 46.1	-37 46	588	7.1v	GLOB CLUS		b 2 ST	
6025	16 03.7	-60 30	720	5.1v	OPEN CLUS		c 1 ST	
6067	16 13.3	-54 13	780	5.6v	OPEN CLUS sp=B3		c 1 ST	4700ly
6087	16 18.9	-57 54	720	5.4v	OPEN CLUS		c 1 ST	
6093	16 17.1	-23 00	534	7.2v	GLOB CLUS	CNGC 6093	D 2 ST	M80
6101	16 25.7	-72 13	642	9.3v	GLOB CLUS		c 2 ST	
6121	16 23.7	-26 31	1578	5.9v	GLOB CLUS sp=G0	CNGC 6121	B 2 ST	M4 14kly
6124	16 25.6	-40 42	1740	5.8v	OPEN CLUS		c 1 ST	
6144	16 27.2	-26 03	558	9.1v	GLOB CLUS		c 2 ST	
6152	16 32.8	-52 38	1800	8.1p	OPEN CLUS		c 1 ST	
6167	16 34.4	-49 36	480	6.7v	OPEN CLUS		c 1 ST	
6169	16 34.1	-44 03	420	6.6p	OPEN CLUS		c 1 S	
6171	16 32.5	-13 02	600	8.1v	GLOB CLUS	CNGC 6171	D 2 ST	M107
6192	16 40.4	-43 23	480	8.5p	OPEN CLUS		c 1 ST	
6193	16 41.4	-48 46	900	5.2v	OPEN CLUS + ENEB + RNEB		c 6 ST	
6200	16 44.3	-47 29	720	7.4v	OPEN CLUS		c 1 S	
6205	16 41.7	+36 27	996	5.9v	GLOB CLUS sp=F6	CNGC 6205	B 2 ST	M13 Hercules Globular
6208	16 49.5	-53 49	960	7.2v	OPEN CLUS		c 1 ST	
6218	16 47.2	-01 57	870	6.6v	GLOB CLUS sp=F8	CNGC 6218	D 2 ST	M12 24kly
6231	16 54.3	-41 48	900	2.6v	OPEN CLUS + ENEB sp=O9		b 6 ST	In 240' ENEB 5800ly
6242	16 55.6	-39 30	540	6.4v	OPEN CLUS		c 1 ST	
6250	16 58.0	-45 48	480	5.9v	OPEN CLUS		c 1 ST	
6254	16 57.1	-04 07	906	6.6v	GLOB CLUS sp=G1	CNGC 6254	D 2 ST	M10 20kly
6259	17 00.7	-44 41	600	8.0v	OPEN CLUS		c 1 ST	
6266	17 01.3	-30 07	846	6.6v	GLOB CLUS OBLATE	CNGC 6266	D 2 ST	M62 Non-symmetrical
6273	17 02.6	-26 15	810	7.2v	GLOB CLUS OBLATE	CNGC 6273	D 2 ST	M19 Oblate Shape Globular
6281	17 04.8	-37 53	480	5.4v	OPEN CLUS + ENEB		c 6 ST	
6284	17 04.5	-24 45	336	9.0v	GLOB CLUS		c 2 ST	
6293	17 10.3	-26 34	474	8.2v	GLOB CLUS		c 2 ST	
6304	17 14.6	-29 28	408	8.4v	GLOB CLUS		c 2 ST	
6316	17 16.6	-28 08	294	9.0v	GLOB CLUS		c 2 ST	
6322	17 18.5	-42 57	600	6.0v	OPEN CLUS		c 1 ST	
6333	17 19.2	-18 31	558	7.9v	GLOB CLUS	CNGC 6333	D 2 ST	M9
6341	17 17.2	+43 09	672	6.5v	GLOB CLUS sp=F1	CNGC 6341	D 2 ST	M92 X-Ray Source 26kly
6353	17 24.7	-49 57	720	6.9v	OPEN CLUS II 3 m	* IC 4651	c 1 ST	
6356	17 23.7	-17 49	432	8.4v	GLOB CLUS		c 2 S	
6362	17 31.8	-67 03	642	8.3v	GLOB CLUS		b 2 ST	
6366	17 27.7	-05 05	498	10.0v	GLOB CLUS		c 2 ST	
6367	17 25.2	+37 45	45	14.5	GALAXY		f 5	
6383	17 34.7	-32 35	300	5.5v	OPEN CLUS + ENEB		c 6 ST	ENEB is 80' in diameter
6388	17 36.3	-44 45	522	6.9v	GLOB CLUS		b 2 ST	
6397	17 40.9	-53 41	1542	5.7v	GLOB CLUS sp=F5		b 2 ST	9kly
6398	17 20.2	+57 55	2010	11.9p	GALAXY dE3	* UGC 10822	c 5 S	33.5x18.9 Maybe Can't See
6400	17 40.8	-36 56	480	8.8p	OPEN CLUS		c 1 ST	
6401	17 38.6	-23 55	336	9.5v	GLOB CLUS		d 2 ST	
6402	17 37.6	-03 17	702	7.6v	GLOB CLUS	CNGC 6402	D 2 ST	M14
6405	17 40.1	-32 13	900	4.2v	OPEN CLUS sp=B4	CNGC 6405	C 1 ST	M6 1500ly
6416	17 44.4	-32 21	1080	8.4v	OPEN CLUS		c 1 ST	
6425	17 47.0	-31 31	480	7.2v	OPEN CLUS		c 1 ST	
6431	17 46.3	+05 43	2460	4.2v	OPEN CLUS III 2 p	* IC 4665	b 1 ST	
6432	17 47.9	-30 00	20	13.6p	PLAN NEB	* *	f 4 S	PK 359-0.1
6441	17 50.2	-37 03	468	7.4v	GLOB CLUS		c 2 ST	
6451	17 50.7	-30 13	480	8.2p	OPEN CLUS		c 1 ST	
6469	17 52.9	-22 21	720	8.2p	OPEN CLUS		c 1 ST	
6475	17 54.0	-34 49	4800	3.3v	OPEN CLUS sp=B5	CNGC 6475	C 1 ST	M7 800ly
6494	17 57.0	-19 01	1620	5.5v	OPEN CLUS sp=B8	CNGC 6494	D 1 ST	M23 1400ly
6514	18 02.3	-23 02	1740	6.3v	DIFF ENEB + OPEN CLUS HII	CNGC 6514	B 6 ST	M20 Trifid Nebula 3500ly
6520	18 03.5	-27 54	360	6.7p	OPEN CLUS		c 1 ST	
6522	18 03.6	-30 02	336	8.6v	GLOB CLUS		c 2 ST	

CNGC Catalog (continued)

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
6523	18 03.2	-24 23	5400	5.2	OPEN CLUS + ENEB sp=O5	CNGC 6523	B 6 ST	M8 Lagoon Nebula 5100ly
6530	18 04.8	-24 20	900	4.6v	OPEN CLUS + ENEB		b 6 ST	In M8 = Lagoon Nebula
6531	18 04.6	-22 30	780	5.9v	OPEN CLUS	CNGC 6531	D 1 ST	M21
6541	18 08.0	-43 44	786	6.6v	GLOB CLUS sp=F6		b 2 ST	13kly
6543	17 58.6	+66 38	350	8.8p	PLAN NEB		c 4 ST	Blue-Green 300ly
6544	18 07.4	-25 01	534	8.3v	GLOB CLUS		b 2 ST	
6546	18 07.2	-23 19	780	8.0v	OPEN CLUS		c 1 ST	
6553	18 09.5	-25 56	486	8.3v	GLOB CLUS		b 2 ST	
6568	18 12.8	-21 35	780	8.6p	OPEN CLUS		c 1 ST	
6569	18 13.6	-31 49	348	8.7v	GLOB CLUS		c 2 ST	
6595	18 17.0	-19 53	660	7.0p	OPEN CLUS + RNEB		c 6 S	
6611	18 18.8	-13 47	2100	6.0v	OPEN CLUS + ENEB sp=O7	CNGC 6611	D 6 ST	M16 Eagle Nebula 5500ly
6613	18 20.0	-17 08	540	6.9v	OPEN CLUS	CNGC 6613	D 1 ST	M18
6618	18 20.8	-16 11	2760	6.0v	DIFF ENEB + OPEN CLUS HII	CNGC 6618	B 6 ST	M17 Omega/Swan/Horseshoe
6624	18 23.7	-30 21	354	8.3v	GLOB CLUS		c 2 ST	
6626	18 24.6	-24 52	672	6.9v	GLOB CLUS	CNGC 6626	D 2 ST	M28
6630	18 20.0	-18 26	4800	4.7	OPEN CLUS	* CNGC 6630	c 1 T	M24 Best with large field
6633	18 27.5	+06 34	1620	4.6v	OPEN CLUS		b 1 ST	
6634	18 33.5	-19 14	2400	6.5	OPEN CLUS SPARSE	* CNGC 6634	c 1	M25 IC 4725 Sparse Cluster
6637	18 31.4	-32 21	426	7.7v	GLOB CLUS	CNGC 6637	D 2 ST	M69
6642	18 31.5	-23 28	270	8.8v	GLOB CLUS		c 2 ST	
6645	18 32.6	-16 54	600	8.5p	OPEN CLUS		c 1 ST	
6653	18 39.0	+05 27	3120	5.4p	OPEN CLUS III 2 m	* IC 4756	c 1 ST	
6656	18 36.3	-23 56	1440	5.1v	GLOB CLUS sp=F7	CNGC 6656	C 2 ST	M22 10kly
6664	18 36.8	-08 14	960	7.8v	OPEN CLUS		c 1 ST	
6681	18 43.2	-32 18	468	8.1v	GLOB CLUS	CNGC 6681	D 2 ST	M70
6694	18 45.4	-09 24	900	8.0v	OPEN CLUS	CNGC 6694	D 1 ST	M26
6705	18 51.1	-06 16	840	5.8v	OPEN CLUS sp=B8	CNGC 6705	C 1 ST	M11 Very rich 5600ly
6709	18 51.5	+10 21	780	6.7v	OPEN CLUS		c 1 ST	
6712	18 53.1	-08 43	432	8.2v	GLOB CLUS		c 2 ST	
6715	18 55.2	-30 28	546	7.7v	GLOB CLUS	CNGC 6715	D 2 ST	M54
6716	18 54.6	-19 53	420	6.9v	OPEN CLUS		c 1 ST	
6720	18 53.5	+33 02	150	9.7p	PLAN NEB RING-LIKE	CNGC 6720	B 4 ST	M57 Ring Nebula 5kly
6723	18 59.6	-36 38	660	7.3v	GLOB CLUS sp=G4		b 2 ST	24kly
6738	19 01.4	+11 36	900	8.3p	OPEN CLUS		c 1 S	
6744	19 09.8	-63 51	930	9.0	GALAXY S(B)b+ II		b 5 ST	15.5x10.2
6752	19 10.9	-59 59	1224	5.4v	GLOB CLUS sp=F6		b 2 ST	17kly
6755	19 07.8	+04 13	900	7.5v	OPEN CLUS		c 1 ST	
6774	19 16.7	-16 17	2880	9.0	OPEN CLUS		c 1 T	
6779	19 16.6	+30 10	426	8.3v	GLOB CLUS	CNGC 6779	D 2 ST	M56
6791	19 20.8	+37 51	960	9.5v	OPEN CLUS		c 1 ST	
6809	19 40.1	-30 56	1140	7.0	GLOB CLUS sp=F5	CNGC 6809	D 2 ST	M55 20kly
6811	19 38.2	+46 34	780	6.8v	OPEN CLUS		c 1 ST	
6822	19 44.9	-14 46	612	9.4	GALAXY Ir+ IV-V		c 5 ST	10.2x9.5
6823	19 43.2	+23 18	720	7.1v	OPEN CLUS + ENEB		c 6 ST	
6830	19 51.1	+23 05	720	7.9v	OPEN CLUS		c 1 ST	
6838	19 53.7	+18 47	432	8.3v	GLOB CLUS	CNGC 6838	D 2 ST	M71
6853	19 59.6	+22 43	910	7.6p	PLAN NEB	CNGC 6853	B 4 ST	M27 Dumbbell Nebula 3500ly
6864	20 06.2	-21 55	360	8.6v	GLOB CLUS	CNGC 6864	D 2 ST	M75
6871	20 05.9	+35 47	1200	5.2v	OPEN CLUS		c 1 ST	
6882	20 11.7	+26 33	1080	8.1v	OPEN CLUS		c 1 S	
6883	20 11.3	+35 51	900	8.0p	OPEN CLUS		c 1 ST	
6885	20 12.0	+26 29	420	5.7p	OPEN CLUS		c 1 ST	
6888	20 12.8	+38 19	1200	13.0v	DIFF ENEB		c 3 ST	Red
6910	20 23.1	+40 47	480	7.4v	OPEN CLUS + ENEB		c 6 ST	In Gamma Cygnus Nebula
6913	20 23.9	+38 32	420	6.6v	OPEN CLUS	CNGC 6913	D 1 ST	M29
6934	20 34.2	+07 24	354	8.9v	GLOB CLUS		c 2 ST	
6939	20 31.4	+60 38	480	7.8v	OPEN CLUS		c 1 ST	
6940	20 34.6	+28 18	1860	6.3v	OPEN CLUS		c 1 ST	
6946	20 34.8	+60 09	660	8.9	GALAXY Sc I	UGC 11597	b 5 ST	11.0x9.8

CNGC Catalog (continued)

CNGC#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
6981	20 53.5	-12 33	354	9.4v	GLOB CLUS	CNGC 6981	D 2 ST	M72
6994	20 59.0	-12 37	168	8.9p	OPEN CLUS	CNGC 6994	D 1 ST	M73
7000	21 01.8	+44 12	7200	6.6	DIFF ENEB HII		b 3 ST	North American Nebula 3kly
7009	21 04.3	-11 22	100	8.3p	PLAN NEB		C 4 ST	Saturn Nebula 3000ly
7036	21 12.1	+47 43	240	6.8v	OPEN CLUS I 1 m	* IC 1369	c 1 ST	
7039	21 12.2	+45 39	1500	7.6v	OPEN CLUS		c 1 S	
7063	21 24.4	+36 30	480	7.0v	OPEN CLUS		c 1 S	
7078	21 30.0	+12 10	738	6.4v	GLOB CLUS sp=F2	CNGC 7078	C 2 ST	M15 X-Ray Source 34kly
7082	21 29.4	+47 05	1500	7.2v	OPEN CLUS		c 1 ST	
7086	21 30.6	+51 35	540	8.4v	OPEN CLUS		c 1 ST	
7089	21 33.5	-00 50	774	6.5v	GLOB CLUS sp=F4	CNGC 7089	C 2 ST	M2 40kly
7092	21 32.2	+48 26	1920	4.6v	OPEN CLUS	CNGC 7092	D 1 ST	M39
7093	21 39.1	+57 30	3000	3.5v	OPEN CLUS + DNEB II 3 m n	* IC 1396	b 6 ST	
7099	21 40.3	-23 11	660	7.5v	GLOB CLUS	CNGC 7099	D 2 S	M30
7143	21 53.4	+47 16	540	7.2v	OPEN CLUS + DNEB IV 2 p n	* IC 5146	c 6 ST	
7160	21 53.7	+62 36	420	6.1v	OPEN CLUS		c 1 ST	
7202	22 10.5	+52 50	480	9.0p	OPEN CLUS II 1 p	* IC 1434	c 1 ST	
7209	22 05.2	+46 30	1500	6.7v	OPEN CLUS		c 1 ST	
7243	22 15.3	+49 53	1260	6.4v	OPEN CLUS		c 1 ST	
7331	22 37.1	+34 26	642	9.5	GALAXY Sb I-II	UGC 12113	C 5 ST	10.7x4.0
7380	22 47.0	+58 06	720	7.2v	OPEN CLUS + ENEB		c 6 ST	Red Nebula
7635	23 20.7	+61 12	900	12.8	DIFF ENEB		c 3 ST	Bubble Nebula Red
7640	23 22.1	+40 51	642	10.9	GALAXY S(B)b+ II:	UGC 12554	c 5 ST	10.7x2.5
7654	23 24.2	+61 36	780	6.9v	OPEN CLUS	CNGC 7654	D 1 ST	M52
7686	23 30.2	+49 08	900	5.6v	OPEN CLUS		c 1 ST	
7790	23 58.5	+61 13	1020	8.5v	OPEN CLUS sp=B1		c 1 ST	10300ly
7793	23 57.9	-32 34	546	9.1	GALAXY Sdm III-IV		c 5 ST	9.1x6.6
7815	00 02.1	-15 28	612	10.9	GALAXY Ir+ IV-V	* UGC A444	c 5 S	10.2x4.2

The Star Catalog

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
* 1	00 08.3	+29 06		2.1v	STAR B8.5p IV:(Hg+Mn)	Alpha And	8 ST	Alpheratz
* 2	00 09.2	+59 10		2.3v	STAR F2 III-IV	Beta Cas	8 ST	Caph
* 3	00 13.2	+15 12		2.8v	STAR B2 IV	Gamma Peg	8 ST	Algenib
* 4	00 25.7	-77 15		2.8v	STAR G1 IV	Beta Hyi	8 ST	
* 5	00 26.3	-42 18		2.4v	STAR K0 IIIb	Alpha Phe	8 ST	Ankaa
* 6	00 39.4	+30 52		3.3v	STAR K3 III	Delta And A	8 ST	
* 7	00 40.5	+56 33		2.2v	STAR K0 IIIa	Alpha Cas	8 ST	Shedir
* 8	00 43.6	-17 59		2.0v	STAR G9.5 III	Beta Cet	8 ST	Diphda
* 9	00 56.7	+60 43	20	2.5v	STAR B0 IVnpe(shell) + ?	Gamma Cas	9 ST	Marj B=8.8
* 10	01 06.1	-46 43	10	3.3v	STAR G8 III	Beta Phe AB	9 ST	B=Similar mag & spectrum
* 11	01 09.8	+35 37		2.1v	STAR M0 IIIa	Beta And	8 ST	Mirach
* 12	01 25.8	+60 15		2.7v	STAR A5 IV	Delta Cas	8 ST	Ruchbah Ecl-Bin @759d
* 13	01 37.7	-57 14		0.5v	STAR B3 Vnp (shell)	Alpha Eri	8 ST	Achernar
* 14	01 54.7	+20 49		2.6v	STAR A5 V	Beta Ari	8 ST	Sharatan
* 15	01 58.7	-61 34		2.9v	STAR A9 III-IVn	Alpha Hyi	8 ST	
* 16	02 04.0	+42 21	100	2.3v	STAR K3 IIb + B9 V + A0 V	Gamma And A	9 ST	Almaak B=5.4 C=6.2
* 17	02 07.2	+23 28		2.0v	STAR K2 IIIab	Alpha Ari	8 ST	Hamal
* 18	02 09.5	+34 59		3.0v	STAR A5 IV	Beta Tri	8 ST	
* 19	02 14.7	+89 17	180	2.0v	STAR F5-8 Ib + F3 V	Alpha UMi A	9 ST	Polaris B=8.2
* 20	02 19.4	-02 58	10	2.1v	STAR M5.5-9 IIIe + Bpe	Omicron Cet A	9 ST	Mira B=9.5
* 21	02 58.3	-40 19		3.2v	STAR A5 IV	Theta Eri A	8 ST	Acamar
* 22	03 02.3	+04 05		2.5v	STAR M1.5 IIIa	Alpha Cet	8 ST	Menkar
* 23	03 04.8	+53 31		2.9v	STAR G8 III + A2 V	Gamma Per	8 ST	
* 24	03 08.2	+40 58		2.1v	STAR B8 V + F:	Beta Per	8 ST	Algol
* 25	03 24.4	+49 52		1.8v	STAR F5 Ib	Alpha Per	8 ST	Mirphak
* 26	03 43.0	+47 48		3.0v	STAR B5 IIIn	Delta Per	8 ST	
* 27	03 47.6	+27 06		2.9v	STAR B7 IIIn	Eta Tau	8 ST	Alcyone
* 28	03 47.2	-74 15		3.2v	STAR M2 III	Gamma Hyi	8 ST	
* 29	03 54.2	+31 54	130	2.9v	STAR B1 Ib + B8 V	Zeta Per A	9 ST	B=9.2
* 30	03 57.8	+40 01	90	2.9v	STAR B0.5 IV + B9.5 V	Epsilon Per A	9 ST	B=7.9
* 31	03 58.0	-13 30		3.0v	STAR M0.5 III-IIIb	Gamma Eri	8 ST	Zaurak
* 32	04 34.0	-55 02	2	3.3v	STAR A0p III:(Si) + B9 IV	Alpha Dor AB	9 ST	A=3.8 B=4.3
* 33	04 35.9	+16 31		0.9v	STAR K5 III	Alpha Tau A	8 ST	Aldebaran
* 34	04 49.9	+06 57		3.2v	STAR F6 V	Pi^3 Ori	8 ST	Hassaleh
* 35	04 57.0	+33 11		2.7v	STAR K3 II	Iota Aur	8 ST	Ayn
* 36	05 02.0	+43 49		3.0v	STAR A9 Iae + B	Epsilon Aur A	8 ST	Anz
* 37	05 05.5	-22 22		3.2v	STAR K5 III	Epsilon Lep	8 ST	
* 38	05 06.6	+41 14		3.2v	STAR B3 V	Eta Ori AB	8 ST	Hoedus II
* 39	05 07.9	-05 05		2.8v	STAR A3 IIIn	Theta Eri	8 ST	Kursa
* 40	05 12.9	-16 12		3.1v	STAR B9p IV: (Hg+Mn)	Mu Lep	8 ST	
* 41	05 14.6	-08 12	90	0.1v	STAR B8 Iae + B5 V	Beta Ori A	9 ST	Rigel B=7.6 C=7.6
* 42	05 16.6	+46 00		0.1v	STAR G6: III + G2: III	Alpha Aur AB	8 ST	Capella
* 43	05 24.5	-02 24		3.3v	STAR B1 IV + B	Eta Ori AB	8 ST	
* 44	05 25.2	+06 21		1.6v	STAR B2 III	Gamma Ori	8 ST	Bellatrix
* 45	05 26.3	+28 37		1.7v	STAR B7 III	Beta Tau	8 ST	Alnath
* 46	05 28.3	-20 46	26	2.8v	STAR G5 II + ?	Beta Lep A	9 ST	B=7.4
* 47	05 32.0	-00 19		2.2v	STAR O9.5 II	Delta Ori A	8 ST	Mintaka
* 48	05 32.7	-17 49		2.6v	STAR F0 Ib	Alpha Lep	8 ST	Arneb
* 49	05 46.5	-05 55	110	2.8v	STAR O9 III + B7 IIIp	Iota Ori A	9 ST	Nair al Saif B=7.3
* 50	05 36.2	-01 12		1.7v	STAR B0 Ia	Epsilon Ori	8 ST	Alnilam
* 51	05 37.6	+21 09		3.0v	STAR B2 IIIpe (shell)	Zeta Tau	8 ST	
* 52	05 39.7	-34 04		2.6v	STAR B7 IV	Alpha Col A	8 ST	Phaet
* 53	05 40.8	-01 56	24	2.1v	STAR O9.5 Ib + B0 III	Zeta Ori A	9 ST	Alnitak B=4.2
* 54	05 47.8	-09 40		2.1v	STAR B0.5 Ia	Kappa Ori	8 ST	Saiph
* 55	05 51.0	-35 46		3.1v	STAR K1.5 III	Beta Col	8 ST	Wezn
* 56	05 55.2	+07 25		0.4v	STAR M2 Iab	Alpha Ori	8 ST	Betelgeuse
* 57	05 59.5	+44 57		1.9v	STAR A1 IV	Beta Aur	8 ST	Menkalinan
* 58	05 59.8	+37 13	40	2.6v	STAR A0p III: (si) + G2 V	Theta Aur AB	9 ST	Bogardus B=7.2 G2V
* 59	06 14.9	+22 31		3.3v	STAR M3 III	Eta Gem	8 ST	Propus
* 60	06 20.3	-30 03		3.0v	STAR B2.5 V	Zeta CMa	8 ST	Phurud

The Star Catalog (continued)

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
* 61	06 22.9	+22 31		2.8v	STAR M3 IIIab	Mu Gem	8 ST	Tejat Posterior
* 62	06 22.7	-17 58		2.0v	STAR B1 II-III	Beta CMa	8 ST	Murzim
* 63	06 24.0	-52 42		-0.7v	STAR A9 II	Alpha Car	8 ST	Canopus
* 64	06 37.7	+16 24		1.9v	STAR A1 IVs	Gamma Gem	8 ST	Alhena
* 65	06 37.7	-43 12		3.2v	STAR B8 IIIn	Nu Pup	8 ST	
* 66	06 44.0	+25 08		3.0v	STAR G8 Ib	Epsilon Gem	8 ST	Mebsuta
* 67	06 45.2	-16 43	95	-1.5v	STAR A0mA1 Va	Alpha CMa A	9 ST	Sirius B=8.5 50y
* 68	06 48.2	-61 56		3.3v	STAR A6 Vn	Alpha Pic	8 ST	
* 69	06 49.9	-50 37		2.9v	STAR K1 III	Tau Pup	8 ST	
* 70	06 58.6	-28 58		1.5v	STAR B2 II	Epsilon CMa A	8 ST	Adara
* 71	07 03.1	-23 50		3.0v	STAR B3 Iab	Omicron^2 CMa	8 ST	
* 72	07 08.4	-26 23		1.8v	STAR F8 Ia	Delta CMa	8 ST	Wezen
* 73	07 13.5	-44 38		2.6v	STAR M5 IIIe	L2 Pup	8 ST	HR2748
* 74	07 17.2	-37 05		2.7v	STAR K3 Ib	Pi Pup	8 ST	
* 75	07 24.2	-26 19		2.5v	STAR B5 Ia	Eta CMa	8 ST	Aludra
* 76	07 27.2	+08 17		2.9v	STAR B8 V	Beta CMi	8 ST	Gomeisa
* 77	07 29.3	-43 17	220	3.3v	STAR K5 III + G5: V	Sigma Pup A	9 ST	
* 78	07 34.6	+31 53	25	1.9v	STAR A1 V + A2mA5	Alpha Gem A	9 ST	Castor A
* 79	07 34.6	+31 53	25	2.9v	STAR A2mA5 + A1 V	Alpha Gem B	9 ST	Castor B
* 80	07 39.3	+05 14	40	0.4v	STAR F5 IV-V + ?	Alpha CMi A	9 ST	Procyon B=10.3
* 81	07 45.4	+28 02		1.1v	STAR K0 IIIb	Beta Gem	8 ST	Pollux
* 82	07 49.3	-24 52		3.3v	STAR G6 Ib	Xi Pup	8 ST	
* 83	08 03.7	-30 01		2.3v	STAR O5 Iafn	Zeta Pup	8 ST	Naos
* 84	08 07.6	-24 19		2.7v	STAR F6 IIp (var)	Rho Pup	8 ST	
* 85	08 09.5	-47 21		1.7v	STAR WC8 + O9 I:	Gamma^2 Vel	8 ST	
* 86	08 22.5	-59 31		1.9v	STAR K3: III	Epsilon Car	8 ST	Avior
* 87	08 44.7	-54 43	20	2.0v	STAR A1 IV	Delta Vel AB	9 ST	B=5.0
* 88	08 55.5	+05 56		3.1v	STAR G9 II-III	Zeta Hya	8 ST	
* 89	08 59.3	+48 03	40	3.1v	STAR A7 IVn + M1 V	Iota UMa A	9 ST	Talitha BC=10.8
* 90	09 08.0	-43 25		2.2v	STAR K4 Ib-IIa	Lambda Vel	8 ST	Suhail
* 91	09 13.3	-69 44		1.7v	STAR A1 III	Beta Car	8 ST	Miaplacidus
* 92	09 17.1	-59 17		2.2v	STAR A8 II	Iota Car	8 ST	Turais
* 93	09 21.1	+34 23		3.1v	STAR K7 IIIab	Alpha Lyn	8 ST	
* 94	09 22.1	-55 01		2.5v	STAR B2 IV-V	Kappa Vel	8 ST	
* 95	09 27.6	-08 39		2.0v	STAR K3 II-III	Alpha Hya	8 ST	Alphard
* 96	09 31.2	-57 01		3.1v	STAR K5 III	N Vel	8 ST	HR3803
* 97	09 33.0	+51 41		3.2v	STAR F6 IV	Theta UMa	8 ST	
* 98	09 45.9	+23 46		3.0v	STAR G1 II	1 Leo	8 ST	Ras Elased Aus
* 99	09 47.2	-65 05	50	3.0v	STAR A5 Ib + B7 III	Nu Car AB	9 ST	B=6.3
*100	10 08.5	+11 58		1.4v	STAR B7 Vn	Alpha Leo A	8 ST	Regulus
*101	10 13.7	-70 02		3.3v	STAR B8 IIIn	Omega Car	8 ST	
*102	10 20.0	+19 51	50	2.6v	STAR K1 IIIb Fe-0.5 + *	Gamma Leo A	9 ST	Algieba B=3.5 G7 III Fe-1
*103	10 22.4	+41 30		3.1v	STAR M0 IIIp	Mu Uma	8 ST	Tania Australis
*104	10 32.0	-61 42		3.3v	STAR B4 Vne	Rho Car	8 ST	HR4140
*105	10 43.0	-64 24		2.8v	STAR B0.5 Vp	Theta Car	8 ST	
*106	10 46.8	-49 26	20	2.7v	STAR G5 III + F8: V	Mu Vel AB	9 ST	B=6.4
*107	10 49.7	-16 11		3.1v	STAR K2 III	Ny Hya	8 ST	
*108	11 01.9	+56 23		2.4v	STAR A0mA1 IV-V	Beta UMa	8 ST	Merak
*109	11 03.8	+61 45	3	1.8v	STAR K0 IIIa + A8 V	Alpha UMa AB	9 ST	Dubhe B=4.8
*110	11 09.7	+44 30		3.0v	STAR K1 III	Psi UMa	8 ST	
*111	11 14.2	+20 32		2.6v	STAR A4 V	Delta Leo	8 ST	Zosma
*112	11 14.2	+15 26		3.3v	STAR A2 Vs	Theta Leo	8 ST	Chort
*113	11 35.8	-63 02		3.1v	STAR B9 III	Lambda Cen	8 ST	
*114	11 49.1	+14 34		2.1v	STAR A3 V	Beta Leo	8 ST	Denebola
*115	11 53.8	+53 41		2.4v	STAR A0 IV-Vn	Gamma UMa	8 ST	Phad
*116	12 08.4	-50 44		2.5v	STAR B2 IVne	Delta Cen	8 ST	
*117	12 10.1	-22 37		3.0v	STAR K3 IIIa	Epsilon Crv	8 ST	Minkar
*118	12 15.1	-58 45		2.8v	STAR B2 IV	Delta Cru	8 ST	
*119	12 15.5	+57 01		3.3v	STAR A2 IV-Vn	Delta UMa	8 ST	Megrez
*120	12 15.8	-17 33		2.6v	STAR B8p III: (Hg+Mn)	Gamma Crv	8 ST	Gienah Ghurab

The Star Catalog (continued)

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q	TAGS	COMMON NAME/COMMENTS
*121	12 26.6	-63 06	50	1.3v	STAR B0.5 IV + B1 Vn	Alpha Cru A	9	ST	Acrux A B=1.7
*122	12 26.7	-63 07	50	1.7v	STAR B1 Vn + B0.5 IV	Alpha Cru B	9	ST	Acrux B A=1.3
*123	12 29.9	-16 31	240	3.0v	STAR B9.5 III + K2 V	Delta Crv A	9	ST	Algorab B=8.3
*124	12 31.2	-57 07		1.6v	STAR M3.5 III	Gamma Cru	8	ST	Gacrux
*125	12 34.4	-23 24		2.7v	STAR G5 II	Beta Crv	8	ST	Kraz
*126	12 37.2	-69 09		2.7v	STAR B2 IV-V	Alpha Mus	8	ST	
*127	12 41.6	-48 58	50	2.9v	STAR B9.5 III + A0 III	Gamma Cen A	9	ST	B=3.0
*128	12 41.5	-48 58	50	3.0v	STAR A0 III + B9.5 III	Gamma Cen B	9	ST	A=2.9
*129	12 41.7	-01 28	40	2.8v	STAR F1 V + F1 V	Gamma Vir AB	9	ST	Porrima B=3.5
*130	12 46.2	-68 07	10	3.1v	STAR B2 V + B2.5 V	Beta Mus AB	9	ST	B=4.1
*131	12 47.7	-59 42		1.2v	STAR B0.5 III	Beta Cru	8	ST	Becrux Mimosa
*132	12 54.0	+55 58		1.8v	STAR A0p IV: (Cr+Eu)	Epsilon UMa	8	ST	Alioth
*133	12 56.1	+38 19		2.9v	STAR A0p III: (Si+Eu+Sr)	Alpha^2 CVn A	8	ST	Cor Caroli B=5.6 F0 V
*134	13 02.2	+10 58		2.8v	STAR G9 IIIab	Epsilon Vir	8	ST	Vindamiatrix
*135	13 19.0	-23 11		3.0v	STAR G8 IIIa	Gamma Hya	8	ST	
*136	13 20.6	-36 43		2.8v	STAR A2 V	Iota Cen	8	ST	
*137	13 24.0	+54 55	140	2.3v	STAR A1p IV: (Si) + A1mA7	Zeta UMa A	9	ST	Mizar B=3.9
*138	13 25.2	-11 10		1.0v	STAR B1 V	Alpha Vir	8	ST	Spica
*139	13 39.9	-53 28		2.3v	STAR B1 III	Epsilon Cen	8	ST	
*140	13 47.6	+49 19		1.9v	STAR B3 V	Eta UMa	8	ST	Alcaid
*141	13 49.6	-42 28		3.0v	STAR B2 IV-Vpne	Mu Cen	8	ST	
*142	13 54.7	+18 24		2.7v	STAR G0 IV	Eta Boo	8	ST	Mufrid
*143	13 55.6	-47 17		2.6v	STAR B2.5 IV	Zeta Cen	8	ST	
*144	14 03.9	-60 24		0.6v	STAR B1 III	Beta Cen AB	8	ST	Hadar
*145	14 06.4	-26 41		3.3v	STAR K2 IIIb	Pi Hya	8	ST	
*146	14 06.7	-36 22		2.1v	STAR K0 IIIb	Theta Cen	8	ST	Menkent
*147	14 15.7	+19 11		0.0v	STAR K1.5 III Fe-0.5	Alpha Boo	8	ST	Arcturus
*148	14 32.1	+38 19		3.0v	STAR A7 III-IV	Gamma Boo	8	ST	Seginus
*149	14 35.5	-42 10		2.4	STAR B1.5 IVpne	Eta Cen	8	ST	
*150	14 39.8	-60 51	210	0.0v	STAR G2 V + K4 V	Alpha Cen A	9	ST	Rigel Kentaurus B=1.3
*151	14 39.8	-60 51	210	1.3v	STAR K4 V + G2 V	Alpha Cen B	9	ST	A=0.0
*152	14 41.9	-47 24		2.3v	STAR B1.5 III	Alpha Lup	8	ST	
*153	14 42.5	-64 59	160	3.2v	STAR A7p (Sr) + K5 V	Alpha Cir	9	ST	B=8.6
*154	14 46.6	+27 04	30	2.4v	STAR K0 II-III + A0 V	Epsilon Boo	9	ST	Izar B=5.1
*155	14 51.1	-51 03		2.8v	STAR A3 IV	Alpha Lib A	8	ST	Zuben Elgenubi
*156	14 50.6	+74 10		2.1v	STAR K4 III	Beta UMi	8	ST	Kocab
*157	14 58.5	-43 08		2.7v	STAR B2 IV	Beta Lup	8	ST	
*158	14 59.2	-42 06		3.1v	STAR B2 V	Kappa Cen	8	ST	
*159	15 04.1	-25 18		3.3v	STAR M4 III	Sigma Lib	8	ST	Brachium
*160	15 17.1	-09 23		2.6v	STAR B8 Vn	Beta Lib	8	ST	Zuben Elschemali
*161	15 18.9	-68 41		2.9v	STAR A1 IIIn	Gamma TrA	8	ST	
*162	15 21.4	-40 39		3.2v	STAR B1.5 IVn	Delta Lup	8	ST	
*163	15 20.7	+71 50		3.1v	STAR A2.5 III	Gamma UMi	8	ST	Pherkad
*164	15 24.9	+58 58		3.3v	STAR K2 III	Iota Dra	8	ST	Ed Asich
*165	15 35.5	+26 43		2.2v	STAR A0 IV	Gamma CrB	8	ST	Alphekka
*166	15 35.1	-41 10	5	2.8v	STAR B2 IVn + B2 IVn	Alpha Lup AB	9	ST	A=3.5 B=3.6
*167	15 54.3	+06 25		2.7v	STAR K2 IIIb (CN1)	Alpha Ser	8	ST	Unukalhai
*168	15 55.1	-63 26		2.9v	STAR F0 IV	Beta Tra	8	ST	
*169	15 58.9	-26 08		2.9v	STAR B1 V + B2 V	Pi Sco A	8	ST	
*170	15 59.5	+25 54		2.0v	STAR gM3: + Bep	T CrB	8	ST	Galt
*171	16 00.3	-22 38		2.3v	STAR B0.3 IV	Delta Sco AB	8	ST	Dschubba
*172	16 05.5	-19 48	10	2.6v	STAR B0.5 IV	Beta Sco AB	9	ST	Graffias B=5.0 C=4.9 @ 14"
*173	16 14.3	-03 43		2.7v	STAR M0.5 III	Delta Oph	8	ST	Yed Prior
*174	16 18.3	-04 36		3.2v	STAR G9.5 IIIb Fe-0.5	Epsilon Oph	8	ST	Yed Posterior
*175	16 21.2	-25 36	200	2.9v	STAR B1 III + B9 V	Sigma Sco A	9	ST	Alniyat B=8.3
*176	16 24.0	+61 31	60	2.7v	STAR G8 IIIab	Eta Dra A	9	ST	B=8.7
*177	16 29.5	-26 26	30	0.9v	STAR M1.5 Iab + B2.5 V	Alpha Sco A	9	ST	Antares B=5.4
*178	16 30.2	+21 29		2.8v	STAR G7 IIIa	Beta Her	8	ST	Kornephoros
*179	16 35.9	-28 13		2.8v	STAR B0 V	Tau Sco	8	ST	
*180	16 37.2	-10 34		2.6v	STAR O9.5 Vn	Zeta Oph	8	ST	Fieht

The Star Catalog (continued)

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q	TAGS	COMMON NAME/COMMENTS
*181	16 41.3	+31 36	11	2.8v	STAR G1 IV + G7 V	Zeta Her AB	9	ST	B=5.5
*182	16 48.7	-69 02		1.9v	STAR K2 IIb - IIIa	Alpha TrA	8	ST	Artia
*183	16 50.2	-34 17		2.3v	STAR K2 III	Epsilon Sco	8	ST	
*184	16 51.9	-38 03		3.0v	STAR B1.5 IVn	Mu^1 Sco	8	ST	
*185	16 57.7	+09 22		3.2v	STAR K2 III	Kappa Oph	8	ST	
*186	16 58.7	-56 00		3.1v	STAR K4 III	Zeta Ara	8	ST	
*187	17 08.7	+65 43		3.2v	STAR B6 III	Zeta Dra	8	ST	Aldhibah
*188	17 10.4	-15 44	10	2.4v	STAR A2 Vs + A3 V	Eta Oph AB	9	ST	Sabik A=3.0 B=3.5
*189	17 12.2	-43 14		3.3v	STAR F2p V: (Cr)	Eta Sco	8	ST	
*190	17 14.7	+14 23		3.1v	STAR M5 Ib-II	Alpha Her AB	8	ST	Ras Algethi
*191	17 15.1	+24 50	90	3.1v	STAR A1 IVn + ?	Delta Her	9	ST	Sarin B=8.8
*192	17 15.1	+36 48		3.2v	STAR K3 IIab	Pi Her	8	ST	
*193	17 22.1	-25 00		3.3v	STAR B2 IV	Alpha Oph	8	ST	
*194	17 25.4	-55 32		2.9v	STAR K3 Ib-IIa	Beta Ara	8	ST	
*195	17 25.5	-56 23		3.3v	STAR B1 Ib	Gamma Ara A	8	ST	
*196	17 30.8	-37 17		2.7v	STAR B2 IV	Upsilon Sco	8	ST	
*197	17 30.4	+52 19	40	2.8v	STAR G2 Ib-IIa + ?	Beta Dra A	9	ST	Restaban B=11.5
*198	17 31.9	-49 52		3.0v	STAR B2 Vne	Alpha Ara	8	ST	
*199	17 33.7	-37 07		1.6v	STAR B1.5 IV	Lambda Sco	8	ST	Shaula
*200	17 25.0	+12 33		2.1v	STAR A5 IIIn	Alpha Oph	8	ST	Rasalhague
*201	17 37.3	-43 00		1.9v	STAR F1 II	Theta Sco	8	ST	Sargas
*202	17 42.6	-39 02		2.4v	STAR B1.5 III	Kappa Sco	8	ST	
*203	17 43.5	+04 34		2.8v	STAR K2 III	Beta Oph	8	ST	Cebalrai
*204	17 47.6	-40 07		3.0	STAR F2 Ia	Iota^1 Sco	8	ST	
*205	17 49.9	-37 02		3.2v	STAR K2 III	G Sco	8	ST	HR6630
*206	17 56.6	+51 29		2.2v	STAR K5 III	Gamma Dra	8	ST	Etamin
*207	17 59.1	-09 46		3.3v	STAR K0 III	Nu Oph	8	ST	
*208	18 05.8	-30 26		3.0v	STAR K0 III	Gamma^2 Sgr	8	ST	Nash
*209	18 17.7	-36 46	40	3.1v	STAR M3.5 IIIab + G8: IV:	Eta Sgr A	9	ST	B=8.3
*210	18 21.0	-29 50		2.7v	STAR K2.5 IIIa	Delta Sgr	8	ST	
*211	18 21.3	-02 54		3.3v	STAR K0 III-IV	Eta Ser	8	ST	
*212	18 24.2	-34 23		1.9v	STAR A0 IIInp (shell)	Epsilon Sgr	8	ST	Kaus Australis
*213	18 28.0	-25 25		2.8v	STAR K1 IIIb	Lambda Sgr	8	ST	Kaus Borealis
*214	18 37.0	+38 47		0.0v	STAR A0 Va	Alpha Lyr	8	ST	Vega
*215	18 45.7	-26 59		3.2v	STAR B8.5 III	Phi Sgr	8	ST	
*216	18 55.3	-26 18		2.0v	STAR B2.5 V	Sigma Sgr	8	ST	Nunki
*217	18 58.9	+32 41		3.2v	STAR B9 III	Gamma Lyr	8	ST	Sulaphat
*218	19 02.7	-29 53	5	2.6v	STAR A2.5 V + A4: V:	Zeta Sgr AB	9	ST	Ascella A=3.2 B=3.5
*219	19 05.5	+13 53		3.0v	STAR A0 IVnn	Zeta Aql A	8	ST	
*220	19 07.0	-27 39		3.3v	STAR K1.5 IIIb	Tau Sgr	8	ST	
*221	19 09.8	-21 02	6	2.9v	STAR F2 II + ? + ?	Pi Sgr ABC	9	ST	Albaldah A=3.7 B=3.8
*222	19 12.6	+67 39		3.1v	STAR G9 III	Delta Dra	8	ST	Nodus Secundus
*223	19 30.8	+27 58	350	3.1v	STAR K3 II + B9.5 V	Beta Cyg A	9	ST	Albireo B=5.1
*224	19 45.0	+45 08	20	2.9v	STAR B9.5 III + F1 V	Delta Cyg AB	9	ST	B=6.4
*225	19 46.3	+10 37		2.7v	STAR K3 II	Gamma Aql	8	ST	Tarazed
*226	19 50.8	+08 52		0.8v	STAR A7 Vn	Alpha Aql	8	ST	Altair
*227	20 11.3	-00 50		3.2v	STAR B9.5 III	Theta Aql	8	ST	
*228	20 21.1	-14 46		3.1v	STAR K0 II + A5 V:n	Beta Cap A	8	ST	Dabih
*229	20 22.2	+40 16		2.2v	STAR F8 Ib	Gamma Cyg	8	ST	Sadr
*230	20 26.9	+15 05		1.9v	STAR B2.5 V	Alpha Pav	8	ST	Peacock
*231	20 37.6	-47 18		3.1v	STAR K0 III (Cn1)	Alpha Ind	8	ST	
*232	20 41.5	+45 17		1.3v	STAR A2 Ia	Alpha Cyg	8	ST	Deneb
*233	20 46.3	+33 58		2.5v	STAR K0 III	Epsilon Cyg	8	ST	Cat
*234	21 13.0	+30 13		3.2v	STAR G8 IIIa Ba 0.6	Zeta Cyg	8	ST	
*235	21 18.6	+62 36		2.4v	STAR A7 IV-V	Alpha Cep	8	ST	Alderamin
*236	21 28.7	+70 33		3.2v	STAR B1 III	Beta Cep	8	ST	Alphirk
*237	21 31.6	-05 35		2.9v	STAR G0 Ib	Beta Aqr	8	ST	Sadalsuud
*238	21 44.2	+09 53		2.4v	STAR K2 Ib	Epsilon Peg	8	ST	Enif '72 flare
*239	21 47.1	-16 07		2.9v	STAR A3mF2 V:	Delta Cap	8	ST	
*240	21 54.0	-37 22		3.0v	STAR B8 III	Gamma Gru	8	ST	

The Star Catalog (continued)

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*241	22 05.8	-00 19		3.0v	STAR G2 Ib	Alpha Aqr	8 ST	Sadalmelik
*242	22 08.3	-46 58		1.7v	STAR B7 IV	Alpha Gru	8 ST	Al Nair
*243	22 18.6	-60 16		2.9v	STAR K3 III	Alpha Tuc	8 ST	
*244	22 42.7	-46 52		2.1v	STAR M5 III	Beta Gru	8 ST	
*245	22 43.1	+30 14		2.9v	STAR G8 II + F0 V	Eta Peg	8 ST	Matar
*246	22 53.6	-15 50		3.3v	STAR A3 IV	Delta Aqr	8 ST	Skat
*247	22 57.7	-29 38		1.2v	STAR A3 V	Alpha PsA	8 ST	Fomalhaut
*248	23 03.8	+28 05		2.4v	STAR M2 II-III	Beta Peg	8 ST	Scheat
*249	23 04.8	+15 12		2.5v	STAR B9.5 V	Alpha Peg	8 ST	Markab
*250	23 39.4	+77 38		3.2v	STAR K1 III-IV	Gamma Cep	8 ST	Alrai
*251	00 06.1	+58 26	15	6.4	STAR 6.4:7.2 @308	ADS 61	9 ST	1980=1.4 @287 107y
*252	00 40.0	+21 27	66	5.5	STAR 5.5:8.7 @194	ADS 558	9 ST	1964 Yellow:Blue
*253	00 42.4	+04 11	15	7.8	STAR 7.8:9.4 @207	ADS 588	9 ST	1980=1.5 @ 200
*254	00 49.9	+27 42	44	6.3	STAR 6.3:6.3 @296	ADS 683	9 ST	1959 p(Yellow:Blue)
*255	00 54.6	+19 11	5	6.2	STAR 6.2:6.9 @211	ADS 746	9 ST	1980=0.5 @ 224 400y
*256	00 55.0	+23 38	8	6.0	STAR 6.0:6.4 @292	ADS 755	9 ST	1980=0.6 @ 259
*257	01 05.7	+21 28	299	5.6	STAR 5.6:5.8 @159	ADS 899	9 ST	1964 Yellow:pBlue
*258	01 09.5	+47 15	5	4.6	STAR 4.6:5.5 @133	ADS 940	9 ST	1980=0.5 @ 140
*259	01 13.7	+07 35	230	5.6	STAR 5.6:6.6 @063	ADS 996	9 ST	1972 Yellow:pBlue
*260	01 39.8	-56 12	113	5.8	STAR 5.8:5.8 @193	p Eri	9 ST	1980=11.1 @195
*261	02 35.5	+89 35	178	2.0	STAR 2.0:8.9 @216	ADS 1477	9 ST	Polaris North Star
*262	01 53.6	+19 18	78	4.6	STAR 4.6:4.7 @000	ADS 1507	9 ST	1969 1831=8.6
*263	01 55.9	+01 51	10	6.8	STAR 6.8:6.8 @057	ADS 1538	9 ST	1980=1.2 @053
*264	01 57.9	+23 36	385	4.7	STAR 4.7:7.7 @047	ADS 1563	9 ST	1973 Yellow:Blue
*265	02 02.0	+02 46	16	4.2	STAR 4.2:5.2 @273	ADS 1615	9 ST	pBlue:pGreen
*266	02 03.9	+42 20	98	2.2	STAR 2.2:5.1 @063	ADS 1630	9 ST	1967 Orange:Emerald
*267	02 12.4	+30 18	39	5.3	STAR 5.3:6.9 @071	ADS 1697	9 ST	1959 Yellow:Blue
*268	02 14.0	+47 29	11	6.6	STAR 6.6:7.1 @274	ADS 1709	9 ST	1980=1.1 @266
*269	02 29.1	+67 25	25	4.6	STAR 4.6:6.9 @232	ADS 1860	9 ST	1980=2.4 @234
*270	02 37.0	+24 39	383	6.6	STAR 6.6:7.4 @276	ADS 1982	9 ST	1973 Yellow:pBlue
*271	02 43.3	+03 15	28	3.6	STAR 3.6:6.2 @297	ADS 2080	9 ST	1974 Yellow:Ashen
*272	03 14.1	+00 11	11	8.8	STAR 8.8:8.8 @139	ADS 2416	9 ST	1980=1.0 @144
*273	03 17.8	+38 38	8	7.8	STAR 7.8:8.3 @259	ADS 2446	9 ST	1980=0.9 @265
*274	03 35.0	+60 02	14	6.8	STAR 6.8:7.6 @261	ADS 2612	9 ST	1980=1.3 @258
*275	03 34.5	+24 28	7	6.6	STAR 6.6:6.7 @002	ADS 2616	9 ST	1980=0.6 @006
*276	03 50.3	+25 35	4	5.8	STAR 5.8:6.2 @211	ADS 2799	9 ST	1980=0.6 @207
*277	03 54.3	-02 57	67	4.7	STAR 4.7:6.2 @347	ADS 2850	9 ST	Fixed
*278	04 09.9	+80 42	7	5.5	STAR 5.5:6.3 @120	ADS 2963	9 ST	1980=0.8 @109
*279	04 07.5	+38 05	16	7.4	STAR 7.4:8.9 @353	ADS 2995	9 ST	1980=1.4 @003
*280	04 16.0	+31 42	7	8.0	STAR 8.0:8.1 @275	ADS 3082	9 ST	1980=0.8 @270
*281	04 20.4	+27 21	496	5.1	STAR 5.1:8.5 @496	ADS 3137	9 ST	1973 Yel/Ora:Blue
*282	04 22.8	+15 03	14	7.3	STAR 7.3:8.5 @352	ADS 3169	9 ST	Purple:Blue
*283	05 07.9	+08 30	7	5.8	STAR 5.8:6.5 @349	ADS 3711	9 ST	1980=0.7 @021
*284	05 14.5	-08 12	92	0.2	STAR 0.2:6.7 @206	ADS 3823	9 ST	Rigel
*285	05 35.2	+09 56	43	3.6	STAR 3.6:5.5 @044	ADS 4179	9 ST	1959 Yellow:Purple
*286	05 35.3	-05 23	132	5.1	STAR 5.4:6.8:6.8	ADS 4186	9 ST	Trapezium in M42
*287	06 28.8	-07 02	99	4.6	STAR 4.6:5.1:5.4	ADS 5107	9 ST	Fixed White Stars
*288	06 46.3	+59 27	17	5.4	STAR 5.4:6.0 @074	ADS 5400	9 ST	1980=1.7 @079
*289	06 45.3	-16 42	45	-1.5	STAR -1.5:8.5 @005	ADS 4523	9 ST	1980=10.3 @049
*290	07 12.8	+27 14	13	7.2	STAR 7.2:7.2 @316	ADS 5871	9 ST	1980=1.3 @320 120y
*291	07 30.3	+49 59	8	8.8	STAR 8.8:8.8 @195	ADS 6117	9 ST	1980=0.8 @189
*292	07 34.6	+31 53	30	1.9	STAR 1.9:2.9 @073	ADS 6175	9 ST	1980=2.2 @095 420y
*293	08 12.2	+17 39	6	5.6	STAR 5.6:6.0 @182	ADS 6650	9 ST	Yellow:Yellow:Blue
*294	09 21.1	+38 11	11	6.5	STAR 6.5:6.7 @271	ADS 7307	9 ST	1980=1.1 @254
*295	10 16.3	+17 44	14	7.2	STAR 7.2:7.5 @181	ADS 7704	9 ST	1980=1.4 @183
*296	10 20.0	+19 51	44	2.2	STAR 2.2:3.5 @124	ADS 7724	9 ST	1980=4.3 @123
*297	11 18.3	+31 32	13	4.3	STAR 4.3:4.8 @060	ADS 8119	9 ST	1980=2.9 @105
*298	11 32.4	+61 05	6	5.8	STAR 5.8:7.1 @295	ADS 8197	9 ST	1980=0.4 @211
*299	12 16.1	+40 39	115	5.9	STAR 5.9:9.0 @260	ADS 8489	9 ST	1925 Gold:Blue
*300	12 24.4	+25 35	16	6.8	STAR 6.8:7.8 @325	ADS 8539	9 ST	1980=1.5 @326

The Star Catalog (continued)

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*301	12 26.6	-63 06	47	1.6	STAR 1.6:2.1 @114	Alpha Cru	9 ST	1943 White:White
*302	12 35.1	+18 22	202	5.2	STAR 5.2:6.8 @271	ADS 8600	9 ST	1963 Yellow:vBlue
*303	12 41.7	-01 28	30	3.5	STAR 3.5:3.5 @287	ADS 8630	9 ST	1980=3.9 @297 White
*304	12 53.3	+21 15	8	5.1	STAR 5.1:7.2 @194	ADS 8695	9 ST	1980=0.8 @175
*305	13 23.9	+54 55	144	2.3	STAR 2.3:4.0 @151	ADS 8891	9 ST	1967
*306	13 49.1	+26 59	34	7.6	STAR 7.6:8.0 @167	ADS 9031	9 ST	1980=3.4 @159
*307	14 15.3	+03 08	12	7.8	STAR 7.8:7.9 @239	ADS 9182	9 ST	1980=1.1 @252
*308	14 20.4	+48 30	13	8.1	STAR 8.1:8.3 @105	ADS 9229	9 ST	1980=1.2 @104 White
*309	14 40.0	-60 51	197	0.0	STAR 0.0:1.2 @214	Alpha Cen	9 ST	1980=21.8 @209
*310	14 41.2	+13 44	10	4.5	STAR 4.5:4.6 @160	ADS 9343	9 ST	1980=1.1 @305 White
*311	14 45.0	+27 04	28	2.5	STAR 2.5:5.0 @339	ADS 9372	9 ST	1971 Orange:Green
*312	14 51.4	+19 06	70	4.7	STAR 4.7:6.9 @326	ADS 9413	9 ST	Orange:Blue
*313	14 51.4	+44 56	11	8.4	STAR 8.4:8.6 @348	ADS 9418	9 ST	1980=1.1 @346
*314	15 18.4	+26 50	15	7.3	STAR 7.3:7.4 @255	ADS 9578	9 ST	1980=1.4 @250
*315	15 23.2	+30 17	10	5.6	STAR 5.6:5.9 @027	ADS 9617	9 ST	1980=0.4 @321
*316	15 24.5	+37 20	22	7.0	STAR 7.0:7.6 @012	ADS 9626	9 ST	1980=2.2 @016
*317	15 34.8	+10 32	39	4.1	STAR 4.1:5.2 @179	ADS 9701	9 ST	1960 Yel-Whi:Ashen
*318	15 39.4	+36 38	63	5.1	STAR 5.1:6.0 @305	ADS 9737	9 ST	1957
*319	16 04.4	-11 22	7	4.9	STAR 4.9:4.9 @044	ADS 9909	9 ST	1980=1.2 @021
*320	16 14.7	+33 51	69	5.6	STAR 5.6:6.6 @235	ADS 9979	9 ST	1980=6.7 @233
*321	16 29.4	-26 26	24	0.9v	STAR 0.9:5.5 @276	ADS 10074	9 ST	Antares Red:pGreen
*322	16 28.9	+18 24	17	7.7	STAR 7.7:7.8 @129	ADS 10075	9 ST	1980=1.4 @136
*323	16 30.9	+01 59	15	4.2	STAR 4.2:5.2 @022	ADS 10087	9 ST	1980=1.3 @ 013
*324	16 56.5	+65 02	14	7.1	STAR 7.1:7.3 @069	ADS 10279	9 ST	1980=1.3 @069
*325	17 05.4	+54 28	19	5.7	STAR 5.7:5.7 @025	ADS 10345	9 ST	1980=1.9 @042
*326	17 15.4	-26 35	48	5.1	STAR 5.1:5.1 @151	ADS 10417	9 ST	Orange:Orange
*327	17 14.7	+14 24	47	3.2	STAR 3.2:5.4 @107	ADS 10418	9 ST	1968 Yellow:Blue
*328	17 23.7	+37 08	40	4.6	STAR 4.6:5.5 @316	ADS 10526	9 ST	1964
*329	18 01.5	+21 36	65	5.1	STAR 5.1:5.2 @258	ADS 10993	9 ST	1953 Yellow:pRed
*330	18 03.1	-08 11	18	5.2	STAR 5.2:5.9 @280	ADS 11005	9 ST	1980=1.9 @277
*331	18 05.3	+02 32	15	4.2	STAR 4.2:6.0 @220	ADS 11046	9 ST	Yel-Ora:Ora
*332	18 25.0	+27 24	7	6.5	STAR 6.5:7.5 @126	ADS 11334	9 ST	1980=0.7 @129
*333	18 35.8	+16 58	15	6.8	STAR 6.8:7.0 @155	ADS 11483	9 ST	1980=1.6 @161
*334	18 44.4	+39 40	26	5.0	STAR 5.0:6.1 @353	ADS 11635	9 ST	1980=2.7 @355 White
*335	18 44.4	+39 36	24	5.2	STAR 5.2:5.5 @080	ADS 11635	9 ST	1980=2.3 @084 White
*336	18 57.1	+32 54	10	5.4	STAR 5.4:7.5 @021	ADS 11871	9 ST	1980=1.1 @051
*337	19 06.4	-37 03	13	4.8	STAR 4.8:5.1 @109	Gamma CrA	9 ST	1980=1.5 @157
*338	19 26.5	+27 19	20	8.1	STAR 8.1:8.4 @292	ADS 12447	9 ST	1980=1.8 @293
*339	19 30.7	+27 58	344	3.2	STAR 3.2:5.4 @054	ADS 12540	9 ST	1967 Gold:Blue
*340	19 45.5	+33 37	24	8.3	STAR 8.3:8.4 @349	ADS 12889	9 ST	1980=2.0 @357
*341	20 21.0	-14 46	2050	3.1	STAR 3.1:6.2 @267	Beta Cap	9 ST	Yellow:Blue
*342	20 46.6	+16 08	98	4.3	STAR 4.3:5.2 @268	ADS 14279	9 ST	1967 Gold:Blue-Gre
*343	20 47.5	+36 29	9	4.9	STAR 4.9:6.1 @011	ADS 14296	9 ST	White:pBlue
*344	20 59.1	+04 18	10	6.0	STAR 6.0:6.3 @285	ADS 14499	9 ST	1980=1.1 @286
*345	21 02.3	+07 11	28	7.3	STAR 7.3:7.5 @217	ADS 14556	9 ST	1961
*346	21 06.7	+38 42	297	5.2	STAR 5.2:6.0 @148	ADS 14636	9 ST	1980=29.0 @146
*347	22 28.8	+00 15	19	4.3	STAR 4.3:4.5 @207	ADS 15971	9 ST	pYellow:pBlue
*348	22 28.2	+57 42	33	9.8	STAR 9.8:11.5 @132	ADS 15972	9 ST	1980=2.6 @176 Reds
*349	22 33.0	+69 55	4	6.5	STAR 6.5:7.0 @094	ADS 16057	9 ST	1980=0.5 @086
*350	23 34.0	+31 20	4	5.6	STAR 5.6:5.7 @280	ADS 16836	9 ST	1980=0.4 @267
*351	21 12.3	-88 58		5.5	STAR VAR 5.3-5.7 F0III	Sigma Oct	8 ST	S-Pole * Sigma Oct

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M#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
M 1	05 34.5	+22 01	360	8.4	PLAN NEB EMIS SN REM	CNGC 1952	B 4 ST	M1 Crab Nebula 4kly
M 2	21 33.5	-00 50	774	6.5v	GLOB CLUS sp=F4	CNGC 7089	C 2 ST	M2 40kly
M 3	13 42.3	+28 23	972	6.4v	GLOB CLUS sp=F7	CNGC 5272	B 2 ST	M3 35kly
M 4	16 23.7	-26 31	1578	5.9v	GLOB CLUS sp=G0	CNGC 6121	B 2 ST	M4 14kly
M 5	15 18.6	+02 05	1044	5.8v	GLOB CLUS sp=F6	CNGC 5904	B 2 ST	M5 26kly
M 6	17 40.1	-32 13	900	4.2v	OPEN CLUS sp=B4	CNGC 6405	C 1 ST	M6 1500ly
M 7	17 54.0	-34 49	4800	3.3v	OPEN CLUS sp=B5	CNGC 6475	C 1 ST	M7 800ly
M 8	18 03.2	-24 23	5400	5.2	OPEN CLUS + ENEB sp=O5	CNGC 6523	B 6 ST	M8 Lagoon Nebula 5100ly
M 9	17 19.2	-18 31	558	7.9v	GLOB CLUS	CNGC 6333	D 2 ST	M9
M 10	16 57.1	-04 07	906	6.6v	GLOB CLUS sp=G1	CNGC 6254	D 2 ST	M10 20kly
M 11	18 51.1	-06 16	840	5.8v	OPEN CLUS sp=B8	CNGC 6705	C 1 ST	M11 Very rich 5600ly
M 12	16 47.2	-01 57	870	6.6v	GLOB CLUS sp=F8	CNGC 6218	D 2 ST	M12 24kly
M 13	16 41.7	+36 27	996	5.9v	GLOB CLUS sp=F6	CNGC 6205	B 2 ST	M13 Hercules Globular
M 14	17 37.6	-03 17	702	7.6v	GLOB CLUS	CNGC 6402	D 2 ST	M14
M 15	21 30.0	+12 10	738	6.4v	GLOB CLUS sp=F2	CNGC 7078	C 2 ST	M15 X-Ray Source 34kly
M 16	18 18.8	-13 47	2100	6.0v	OPEN CLUS + ENEB sp=O7	CNGC 6611	D 6 ST	M16 Eagle Nebula 5500ly
M 17	18 20.8	-16 11	2760	6.0v	DIFF ENEB + OPEN CLUS HII	CNGC 6618	B 6 ST	M17 Omega/Swan/Horseshoe
M 18	18 20.0	-17 08	540	6.9v	OPEN CLUS	CNGC 6613	D 1 ST	M18
M 19	17 02.6	-26 15	810	7.2v	GLOB CLUS OBLATE	CNGC 6273	D 2 ST	M19 Oblate Shape Globular
M 20	18 02.3	-23 02	1740	6.3v	DIFF ENEB + OPEN CLUS HII	CNGC 6514	B 6 ST	M20 Trifid Nebula 3500ly
M 21	18 04.6	-22 30	780	5.9v	OPEN CLUS	CNGC 6531	D 1 ST	M21
M 22	18 36.3	-23 56	1440	5.1v	GLOB CLUS sp=F7	CNGC 6656	C 2 ST	M22 10kly
M 23	17 57.0	-19 01	1620	5.5v	OPEN CLUS sp=B8	CNGC 6494	D 1 ST	M23 1400ly
M 24	18 20.0	-18 26	4800	4.7	OPEN CLUS	CNGC 6630	c 1 T	M24 Best with large field
M 25	18 33.5	-19 14	2400	6.5	OPEN CLUS SPARSE	CNGC 6634	c 1	M25 IC 4725 Sparse Cluster
M 26	18 45.4	-09 24	900	8.0v	OPEN CLUS	CNGC 6694	D 1 ST	M26
M 27	19 59.6	+22 43	910	7.6p	PLAN NEB	CNGC 6853	B 4 ST	M27 Dumbbell Nebula 3500ly
M 28	18 24.6	-24 52	672	6.9v	GLOB CLUS	CNGC 6626	D 2 ST	M28
M 29	20 23.9	+38 32	420	6.6v	OPEN CLUS	CNGC 6913	D 1 ST	M29
M 30	21 40.3	-23 11	660	7.5v	GLOB CLUS	CNGC 7099	D 2 S	M30
M 31	00 42.8	+41 17	10680	3.5	GALAXY Sb I-II	UGC 454	B 5 ST	M31 Andromeda Gal 178x63
M 32	00 42.8	+40 53	456	8.2	GALAXY E2	UGC 452	C 5 ST	M32 Comp of M31 7.6x5.8
M 33	01 33.9	+30 40	3720	5.7	GALAXY Sc II-III	UGC 1117	C 5 ST	M33 Triangulum Gal 62x39
M 34	02 42.0	+42 47	2100	5.2v	OPEN CLUS	CNGC 1039	C 1 ST	M34
M 35	06 08.9	+24 21	1680	5.1v	OPEN CLUS sp=B5	CNGC 2168	C 1 ST	M35 2800ly
M 36	05 36.2	+34 08	720	6.0v	OPEN CLUS	CNGC 1960	C 1 ST	M36
M 37	05 52.4	+32 33	1440	5.6v	OPEN CLUS sp=B8	CNGC 2099	C 1 ST	M37 4200ly
M 38	05 28.7	+35 51	1260	6.4v	OPEN CLUS sp=B5	CNGC 1912	C 1 ST	M38 4600ly
M 39	21 32.2	+48 26	1920	4.6v	OPEN CLUS	CNGC 7092	D 1 ST	M39
M 40	12 36.4	+25 59	972	9.6	GALAXY Sb I: + 3-SYS FNT	UGC 7772	B A ST	M40 16.2x2.8 Edge-On Lane
M 41	06 47.1	-20 45	2280	4.5v	OPEN CLUS sp=B4	CNGC 2287	C 1 ST	M41 2200ly
M 42	05 35.3	-05 23	3960	3.9	DIFF RNEB + ENEB	CNGC 1976	A 3 ST	M42 Orion Nebula Blue+Red
M 43	05 35.5	-05 16	1200	5.8	DIFF RNEB + ENEB	CNGC 1982	C 3 ST	M43 Orion Nebula Extension
M 44	08 40.1	+19 59	5700	3.1v	OPEN CLUS sp=A0	CNGC 2632	C 1 ST	M44 Praesepe/Beehive 590ly
M 45	03 47.1	+24 07	7200	1.6	OPEN CLUS + RNEB sp=B6	CNGC 1457	c 6 ST	M45 Pleiades 410ly
M 46	07 41.9	-14 49	1620	6.1v	OPEN CLUS sp=B8	CNGC 2437	C 1 ST	M46 5400ly (+CNGC 2438 PN)
M 47	07 36.6	-14 29	1800	4.4v	OPEN CLUS sp=B3	CNGC 2422	D 1 ST	M47 1600ly
M 48	08 13.7	-05 47	3240	5.8v	OPEN CLUS	CNGC 2548	D 1 ST	M48
M 49	12 29.8	+08 00	534	8.4	GALAXY E4	UGC 7629	C 5 ST	M49 8.9x7.4
M 50	07 02.9	-08 20	960	5.9v	OPEN CLUS	CNGC 2323	D 1 ST	M50
M 51	13 30.0	+47 11	660	8.4	GALAXY Sc I 2-SYS FACE	UGC 8493	B A ST	M51 11.0x7.8 Whirlpool Gal
M 52	23 24.2	+61 36	780	6.9v	OPEN CLUS	CNGC 7654	D 1 ST	M52
M 53	13 13.0	+18 10	756	7.7v	GLOB CLUS	CNGC 5024	D 2 ST	M53
M 54	18 55.2	-30 28	546	7.7v	GLOB CLUS	CNGC 6715	D 2 ST	M54
M 55	19 40.1	-30 56	1140	7.0	GLOB CLUS sp=F5	CNGC 6809	D 2 ST	M55 20kly
M 56	19 16.6	+30 10	426	8.3v	GLOB CLUS	CNGC 6779	D 2 ST	M56
M 57	18 53.5	+33 02	150	9.7p	PLAN NEB RING-LIKE	CNGC 6720	B 4 ST	M57 Ring Nebula 5kly
M 58	12 37.8	+11 49	324	9.8	GALAXY Sb	UGC 7796	C 5 ST	M58 5.4x4.4 Near CNGC 4621
M 59	12 42.1	+11 38	306	9.8	GALAXY E3	UGC 7858	D 5 ST	M59 5.1x3.4 Near CNGC 4579
M 60	12 43.7	+11 33	432	8.8	GALAXY E1	UGC 7898	D 5 ST	M60 7.2x6.2 Near CNGC 4621

The M (Messier) Catalog (continued)

M#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	QTAGS	COMMON NAME/COMMENTS
M 61	12 22.0	+04 28	360	9.7	GALAXY Sc I 2-SYS	UGC 7420	DA ST	M61 6.0x5.5 Face-On
M 62	17 01.3	-30 07	846	6.6v	GLOB CLUS OBLATE	CNGC 6266	D 2 ST	M62 Non-symmetrical
M 63	13 15.8	+42 02	738	8.6	GALAXY Sb+ II	UGC 8334	C 5 ST	M63 12.3x7.6 Sunflower Gal
M 64	12 56.7	+21 41	558	8.5	GALAXY Sb-	UGC 8062	C 5 ST	M64 9.3x5.4 Black Eye Gal
M 65	11 18.9	+13 05	600	9.3	GALAXY Sb II:	UGC 6328	C 5 ST	M65 10.0x3.3 Near M66
M 66	11 20.2	+12 59	522	9.0	GALAXY Sb+ II:	UGC 6346	C 5 ST	M66 8.7x4.4 Near M65
M 67	08 51.1	+11 49	1800	6.9v	OPEN CLUS sp=F2	CNGC 2682	D 1 ST	M67 Very old 2700ly
M 68	12 39.4	-26 46	720	8.2v	GLOB CLUS	CNGC 4590	D 2 ST	M68
M 69	18 31.4	-32 21	426	7.7v	GLOB CLUS	CNGC 6637	D 2 ST	M69
M 70	18 43.2	-32 18	468	8.1v	GLOB CLUS	CNGC 6681	D 2 ST	M70
M 71	19 53.7	+18 47	432	8.3v	GLOB CLUS	CNGC 6838	D 2 ST	M71
M 72	20 53.5	-12 33	354	9.4v	GLOB CLUS	CNGC 6981	D 2 ST	M72
M 73	20 59.0	-12 37	168	8.9p	OPEN CLUS	CNGC 6994	D 1 ST	M73
M 74	01 36.7	+15 47	612	9.2	GALAXY Sc I	UGC 1149	D 5 ST	M74 10.2x9.5
M 75	20 06.2	-21 55	360	8.6v	GLOB CLUS	CNGC 6864	D 2 ST	M75
M 76	01 42.0	+51 34	290	12.2	PLAN NEB PART OF 0651	CNGC 0650	C 4 ST	M76 Little Dumbbell Nebula
M 77	02 42.7	-00 01	414	8.8	GALAXY Sbp SEYFERT	UGC 2188	D 5 ST	M77 6.9x5.9 Seyfert Galaxy
M 78	05 46.8	+00 03	480	11.3	DIFF RNEB	CNGC 2068	C 3 ST	M78 Blue 1500ly
M 79	05 24.2	-24 31	522	8.0v	GLOB CLUS	CNGC 1904	D 2 ST	M79
M 80	16 17.1	-23 00	534	7.2v	GLOB CLUS	CNGC 6093	D 2 ST	M80
M 81	09 55.7	+69 04	1542	6.9	GALAXY Sb I-II	CNGC 3031	C 5 ST	M81 25.7x14.1 Near M82
M 82	09 55.9	+69 41	672	8.4	GALAXY P EDGE-ON	UGC 5322	C 5 ST	M82 11.2x4.6 Exploding
M 83	13 37.1	-29 51	672	8.2	GALAXY Sc I-II FACE-ON	CNGC 5236	B 5 ST	M83 11.2x10.2
M 84	12 25.1	+12 53	300	9.3	GALAXY E1	UGC 7494	C 5 ST	M84 5.0x4.4 Near M86
M 85	12 25.5	+18 11	426	9.2	GALAXY Ep 2-SYS	UGC 7508	CA ST	M85 7.1x5.2
M 86	12 26.3	+12 56	444	9.2	GALAXY E3	UGC 7532	C 5 ST	M86 7.4x5.5
M 87	12 30.9	+12 23	432	8.6	GALAXY E1 + E0 2-SYS	UGC 7654	DA ST	M87 7.2x6.8 + CNGC 4471
M 88	12 32.1	+14 25	414	9.5	GALAXY Sb+ I MULTI-ARM	UGC 7675	D 5 ST	M88 6.9x3.9
M 89	12 35.7	+12 33	252	9.8	GALAXY E0	UGC 7760	D 5 ST	M89 4.2x4.2
M 90	12 36.9	+13 09	570	9.5	GALAXY Sb+	UGC 7786	C 5 ST	M90 9.5x4.7
M 91	12 35.5	+14 29	324	10.2	GALAXY SBb + Sc 2-SYS	UGC 7753	DA ST	M91 5.4x4.4 Near CNGC 4571
M 92	17 17.2	+43 09	672	6.5v	GLOB CLUS sp=F1	CNGC 6341	D 2 ST	M92 X-Ray Source 26kly
M 93	07 44.6	-23 52	1320	6.2v	OPEN CLUS + DNEB	CNGC 2447	D 6 ST	M93 Includes dark nebula
M 94	12 50.9	+41 08	660	8.2	GALAXY Sb-p II:	UGC 7996	C 5 ST	M94 11.0x9.1
M 95	10 43.9	+11 42	444	9.7	GALAXY S(B)b II	UGC 5850	C 5 ST	M95 7.4x5.1 Near M96
M 96	10 46.7	+11 49	426	9.2	GALAXY Sbp	UGC 5882	C 5 ST	M96 7.1x5.1 Near M95
M 97	11 14.8	+55 02	194	12.0p	PLAN NEB	CNGC 3587	C 4 ST	M97 Owl Nebula 12kly
M 98	12 13.9	+14 54	570	10.1	GALAXY Sb I-II: 3-SYS	UGC 7231	DA ST	M98 9.5x3.2
M 99	12 18.9	+14 25	324	9.8	GALAXY Sc I NEAR FACE-ON	UGC 7345	D 5 ST	M99 5.4x4.8
M100	12 23.0	+15 49	414	9.4	GALAXY Sc I FACE-ON	UGC 7450	D 5 ST	M100 6.9x6.2 Brite Nucleus
M101	14 03.3	+54 21	1614	7.7	GALAXY Sc I FACE-ON	UGC 8981	C 5 S	M101 26.9x26.3 Pinwheel
M102	15 06.5	+55 45	312	10.0	GALAXY E6p 2-SYS	UGC 9723	DA ST	M102 5.2x2.3
M103	01 33.3	+60 43	360	7.4v	OPEN CLUS	CNGC 0581	D 1 ST	M103
M104	12 39.9	-11 38	534	8.3	GALAXY Sb-	CNGC 4594	C 5 ST	M104 8.9x4.1 “Sombrero”
M105	10 47.8	+12 35	270	9.3	GALAXY E1 2-SYS	UGC 5902	CA ST	M105 4.5x4.0
M106	12 19.0	+47 18	1092	8.3	GALAXY Sb+p	UGC 7353	C 5 ST	M106 18.2x7.9
M107	16 32.5	-13 02	600	8.1v	GLOB CLUS	CNGC 6171	D 2 ST	M107
M108	11 11.6	+55 41	498	10.1	GALAXY Sc NEAR EDGE-ON	UGC 6225	C 5 ST	M108 8.3x2.5 Near M97
M109	11 57.6	+53 22	456	9.8	GALAXY S(B)b+ I	UGC 6937	D 5 ST	M109 7.6x4.9
M110	00 40.4	+41 42	1044	8.0	GALAXY E6:	UGC 426	C 5 ST	M110 Comp of M31 17.4x9.8

APPENDIX D: MAINTAINING YOUR LX200

Keeping Your Telescope Clean and Dry

Preventive maintenance is the best course for keeping astronomical equipment in top working order. The measures taken when observing, and storing equipment between observing runs can add years of trouble-free use.

Dust and moisture are the two main problems. When observing, use a proper-fitting dew shield. The dew shield not only prevents dew from forming, and dust from settling on the corrector-plate lens, it prevents stray light from reducing image contrast.

Although dew shields go a long way to prevent moisture build-up, there can be times when the telescope optics have a uniform coating of moist dew. This is not particularly harmful, as long as you let the dew evaporate. Use a hair dryer or just set up the telescope indoors with the dust covers removed. Let the foam-lined case for the LX200 dry indoors for a day if the night was moist (packing your telescope away in a moist case can give it a steam bath later).

CAUTION: Any time the LX200 is being stored or transported, be sure to release the R.A. and Dec. locks, to prevent serious damage to the drive gears.

CAUTION: Never attempt to wipe down dew-covered optics. Dust and dirt may be trapped with the collected dew; you may scratch the optics. After the dew evaporates, you will most likely find the optics in fine condition for the next observing session.

If you live in a very moist climate, you may need to use silica desiccant stored in the telescope's case to ward off moisture and the possibility of fungus growing on and within the coatings of the optics. Replace the desiccant as often as necessary.

If you live in a coastal or tropical zone, cover the electronic ports on the power panel and the keypad with gaffer's tape to reduce corrosion on the metal contacts. Apply a dab of a water-displacement solution (*e.g.,* WD-40) with a small brush on all interior metal contacts and the input-cord metal contacts. Keep the keypad and all separate accessories in sealable plastic bags with silica desiccant.

A thick layer of dust will attract and absorb moisture on all exposed surfaces. Left unattended, this can cause damaging corrosion. To reduce dust when you are observing, set up the telescope on a small section of indoor/outdoor carpet. If you are observing for more than one night in a row, you can leave the telescope set up but covered with a large plastic bag (such as the one supplied with the telescope). You can seal off the rear cell opening of the LX200 from the elements by threading on the optional accessory Skylight 1A Dust Seal. Eyepieces, diagonals, and other accessories are best kept in plastic bags and stored in cases, such as the Meade #50 Accessory Case.

To prevent corrosion, routinely clean all the non-optical surfaces of the LX200 with a soft rag and alcohol. You can also keep the cast-metal surfaces and individual exposed screws looking new and corrosion free by wiping them with a water-displacement solution. Do not smear the solution onto any optical surface, and wipe up any excess solution with a clean dry cloth. You can polish the painted tube with a liquid car polish and a soft rag.

The most common telescope-maintenance error is cleaning the optics too often. A little dust on any of the optical surfaces causes virtually no degradation of optical performance. Some small particles on the inside or outside of telescope optics are of no concern. Should the optics get more dust on them than you would care for, use a photographic-grade camel-hair brush, with very gentle strokes. You can also blow off dust with an ear syringe (available from a local pharmacy).

There is a point when the optics must be cleaned: when you can easily see a thin layer of fine particulates that make the optics look very slightly hazy. To clean the optics make your own lens-cleaning solutions, since it is impossible to know all of the ingredients used in commercial lens cleaners. Pure isopropyl alcohol (90% or more) will clean most residual film build-up on optical surfaces (and metal surfaces too).

The Three-Part Solution

You can remove organic materials (*e.g.,* fingerprints) on the front lens with a solution of 3 parts distilled water to 1 part isopropyl alcohol. A single drop of biodegradable dishwashing soap may be added per pint of solution. Use soft, white facial tissues and make short, gentle strokes. Change tissues often.

CAUTION: Do not use scented, colored, or lotioned tissues;they can damage the optics.

Sprayer bottles are a convenient dispenser of lens-cleaning solutions onto the tissues. If the optics are small (*e.g.,* viewfinders or eyepieces), you can roll the tissue to the appropriate thickness and then break it in half to create two cleaning wands. Avoid the so-called lens cleaning papers (many contain fiberglass), lens cloths, or chamois.

Before attempting to clean an optical surface with a liquid solution, you must remove as much dust as possible with forced air and/or gentle strokes with a photographic-grade camel-hair brush. The forced-air can come from a rubber ear syringe, or canned compressed air from a photographic supply store. Hold the canned vertical and spray air on your hand before aiming at the optics to see if any of propellant (solid material) comes out. Propellant is very difficult to remove from optics, so take care not to tip the can when using it. If you have access to a compressor hose, be sure that it is filtered to prevent oil from spraying on the optics.

Once you have removed most of the dust and large particles, begin cleaning with the mixture described above. Pour or spray enough solution onto a pillow or wand of tissue until it is quite wet. If you are cleaning a corrector plate, use radial strokes with a smooth pillow of tissue, starting from the center out, using no pressure. If you are cleaning small optical surfaces, use the rolled wands of tissue starting from the edges then spiraling in to the center, again using no pressure. Never pour or spray the solution onto the corrector plate or eyepieces themselves, as the liquid may go behind or between lenses, where it is difficult or impossible to reach. Never attempt to disassemble an eyepiece to clean the inner elements, as you will certainly not be able to center and re-assemble the optical train.

Use dry tissue for the final clean up, again using no pressure. If some residue remains, repeat the procedure using the three-part solution described above and the same cleaning techniques.

The inside surface of the corrector plate and secondary mirror may become dirty from particles falling inside the tube when you remove or replace the rear dust cover or when you thread on accessories. To reduce the chance of interior contamination, the Meade Skylight 1ADust Seal is very effective. If you do not use the Dust Seal, have the rear cell pointed downward when you replace the rear dust cover or when you attach accessories.

Another more serious, but still not damaging possibility is that of a hazy (usually uneven) film building up on the inside of the corrector plate. This can come from environmental pollutants or temperature changes causing outgassing or water condensation from the interior paint.

You can clean the interior of the optical system yourself or have it done professionally. If you do it yourself, handle the optics very carefully. Any impact or rough handling can damage the surfaces. This may require complete optical replacement at Meade Instruments at substantial cost. Meade Instruments assumes no liability for damage caused by the customer.

The techniques described above are used while you clean the interior of the optical system, with one exception: **Do not apply cleaning solutions to the front surface mirrored optics. Use only the soft camel-hair brush and the ear syringe for removing particles.** You can clean the corrector plate in the normal manner.

To remove the corrector plate, follow this procedure:

1. Remove the six stainless-steel screws that hold the corrector-plate retaining ring with the raised white lettering in place. Do this with the drive base placed flat on a work bench and the optical tube assembly pointed up at a 45° angle, with the Dec. lock secure to prevent accidental dislodging of the corrector plate.
2. Remove the retaining ring and locate the two white alignment marks, one at the edge of the corrector plate lens and one beside it on the black metal front cell. These two marks line up and serve as the precise rotational position of the corrector plate in the optical train. If there are no marks, make them yourself with a small paintbrush and some white pain so you can return the corrector plate to the front cell in the same position from which you removed it.
3. Remove the corrector plate from the telescope, holding it by the plastic central secondary housing. Gently flip it over so that the secondary mirror faces you, then reinsert the corrector plate back into the front cell. This allows you full access to clean the interior optical surfaces without touching them with your fingers.
4. When cleaning is complete, replace the corrector plate in its original position, carefully lining up the rotational index marks described above. Replace the retainer. Partially thread in all the stainless steel screws, then, one at a time, snug the screws down to prevent the corrector plate from rotating in the front cell. Take care not to overtighten the screws, as this will stress the corrector plate lens.
5. A final check of the optical system is to inspect for proper collimation (alignment) of the optics.

Collimation (Alignment) of the Optical System

The optical collimation (alignment) of any astronomical telescope used for serious purposes is important. With the Schmidt-Cassegrain design of the 16" LX200, such collimation is essential. Read and understand this section so that your LX200 can give the best optical performance.

For final optical tests, Meade precisely collimates every Schmidt-Cassegrain at the factory before shipment because shipment and normal handling can degrade the optical alignment. The design of the optical support system simplifies collimation. Even the uninitiated can collimate the optics to the same high precision that is performed at the Meade Instruments Optical Laboratories.

To check the collimation of your LX200, center a bright star that is overhead or use a hot spot of sunlight reflected from a chrome car bumper or a telephone-pole insulator, with the supplied 26mm eyepiece. To evaluate the alignment, let the telescope either cool down or warm up to the ambient temperature where the instrument is set up. Temperature differences between the optics and the outside air can distort the images.

With the star or hot spot centered, de-focus the image. You will notice that the unfocused star image looks like a ring of light (the dark center of the ring is the shadow of the secondary mirror). Turn the focus knob until the ring of light fills about 1/8th of the eyepiece field. If you keep de-focusing the star past about one-eighth of a field, the ring looks perfectly concentric (as in 3, Fig. 16) even if the optics are out of alignment, thus preventing you from seeing any misalignments. If the ring of light does not appear concentric or if the dark center appears to be offset in the in the ring of light, follow this procedure:

1. To make collimation easy, the only adjustments possible on the 16" LX200 come from the three set-screws (shown in Fig.15) located at the edge of the outer surface of the secondary mirror housing.

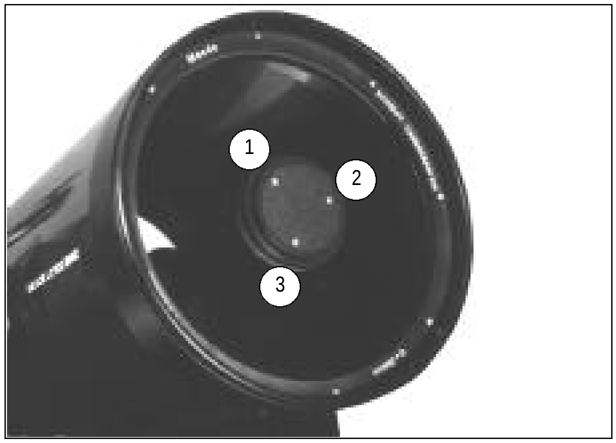

Fig.15: Collimation of the optical system.
(1), (2), (3) Set-screws for adjusting collimation.

2. While looking at the de-focused star image and noticing which direction the darker shadow is offset in the ring of light or noticing which part of the ring is the thinnest (1, Fig. 16), place your index finger in front of the telescope so that it touches one of the collimation set-screws. You will see the shadow of your finger in the ring of light. Move your finger (or have an assistant move a finger) around the edge of the black plastic secondary mirror support until you see the shadow of the finger crossing the thinnest part of the ring of light. At this point, look at the front of the telescope, where your (or your assistant's) finger is aiming. It is either pointing directly at a set-screw or it is between two set-screws aiming at the set-screw on the far side of the black plastic secondary mirror support. This is the set-screw that you will adjust.

CAUTION: DO NOT FORCE THE THREE COLLIMATION SET-SCREWS PAST THEIR NORMAL TRAVEL AND DO NOT LOOSEN THEM MORE THAN TWO FULL TURNS (COUNTER-CLOCKWISE) OR THE SECONDARY MIRROR MAY COME LOOSE FROM ITS SUPPORT. THE ADJUSTMENTS ARE VERY SENSITIVE. USUALLY, TURNING A COLLIMATION SCREW ONLY ONE-HALF A TURN GIVES DRAMATIC RESULTS.

3. Using the telescope's slow motion controls, move the de-focused image to the edge of the eyepiece field of view (2, Fig. 16), in the direction that the darker shadow is offset in the ring of light.
4. Turn the set-screw that you found with the pointing exercise while looking in the eyepiece. Notice that the star image moves across the field. If, while turning, the out-of-focus star image flies out of the eyepiece field, you are turning the screw the wrong way. Turn in the opposite direction and bring the image to the center of the field.

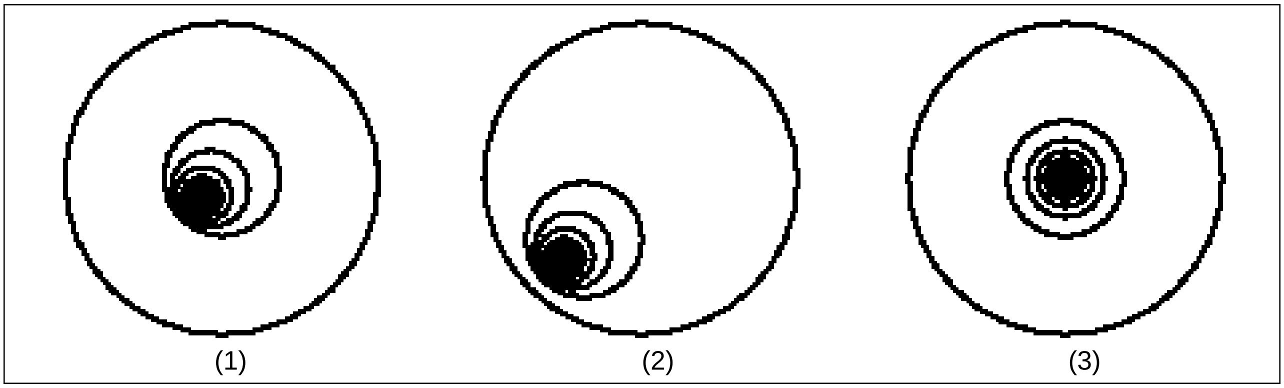

Fig.16: De-focused Star Images.

5. If, while turning, you feel the screw get very loose, tighten the other two screws by equal amounts. If while turning, the set-screw gets too tight, unthread the other two by equal amounts.
6. When you bring the image to center (3, Fig. 16), carefully examine the concentricity of the ring of light. If you find that the dark center is still off in the same direction, continue to make the adjustment in the original turning direction. If it is now off in the opposite direction, you have turned too far; turn in the opposite direction. Always double check the image in the center of the field of the eyepiece.
7. You may find after your initial adjustment that the dark center is off in a new direction (*e.g.*, instead of side-to-side, it is off in an up-and-down direction). If this is the case, follow steps 2 through 6 above to find the new adjustment.
8. Now try a higher power (*e.g.*, 9mm or less) eyepiece and repeat the above tests. Any lack of collimation at this point will require only very slight adjustments of the three set-screws. You now have good collimation.
9. As a final check on alignment, examine the star image in-focus with the higher-power eyepiece as suggested above, under good seeing conditions (steady atmospheric conditions). The star point should appear as a small central dot (the Airy disc) with a diffraction ring surrounding it. For a final precision collimation, make extremely slight adjustments of the three set-screws, if necessary, to center the Airy disc in the diffraction ring. You now have the best alignment of the optics possible.

Right Ascension (R.A.) Lock

After a period of time, it is possible that the R.A. lock (6, Fig. 1) of the LX200 will not tighten sufficiently due to internal wear of the clutch mechanism. In such an event, remove the R.A. lock lever, using one of the hex wrenches supplied with the telescope. Then, with a pair of pliers, tighten the shaft protruding outward from the drive base until you cannot easily rotate the fork arm in R.A. (Take care in this operation not to damage the cosmetic finish of your LX200). Replace the R.A. lock lever so that the handle points straight out from the cross-bar connecting the fork arm.

Behind the Power Panel

The LX200 power panel houses the backup replaceable battery (1, Fig. 17) for the clock and calendar and a replaceable standard 3.0-amp slow-blow fuse (2, Fig. 17). The long-life lithium battery (Panasonic CR2032 3vDC or Duracell DL2032B) is stored behind the front panel of the drive base. The battery requires replacement every few years. Replace the battery by unthreading the four Phillips-head screws that secure the front panel to the drive base. Then, with a thin flat-head screwdriver, lift the small coin-size battery out of its holder. The new battery slides into place.

The 3-amp slow-blow fuse will sacrifice itself to protect the LX200 electronics in the event that the telescope is prevented from completing a GO TO function (*e.g.*, the tube runs into something that keeps it from slewing).

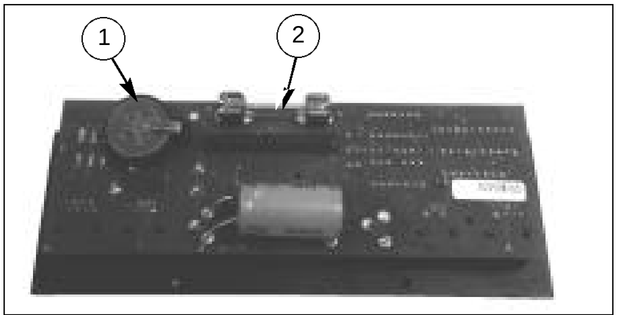

Fig.17: Reverse Side of Power Panel. (1) Battery; (2) Fuse.

Factory Service and Repairs

Meade LX200 models have been designed and manufactured to give years of trouble-free operation; repairs should rarely be necessary. If a problem does occur, first write or call our Customer Service Department.

Do not return the telescope until you have communicated with us because the great majority of problems can be handled without returning the telescope to us. However, should the telescope require factory servicing, a Meade Instruments Customer Service Representative will issue a Return Goods Authorization (RGA) number and give you full instructions on how to use it.

Product returned without the RGA number may greatly delay any servicing or repairs. When telephoning or writing, please explain the exact nature of the problem so that we may offer a prompt remedial procedure. Be sure to include your full name, address, phone number, and fax number.

If you live outside the United States, contact your Authorized Meade Distributor from whom you purchased the telescope.

You can reach the Meade Instruments Customer Service Department by mail, phone, or fax at:

Meade Instruments Corporation
6001 Oak Canyon
Irvine, CA 92618-5200
Telephone (949) 451-1450
Fax (949) 451-1460.

Outside the U.S., dial your International Access Code, then 1, then the ten-digit number given above. Customer Service hours are 8:30 AM to 4:30 PM, Pacific Time, Monday through Friday.

APPENDIX E:
LX200 PERSONAL COMPUTER CONTROL

Remote operation of a computerized telescope has been only a dream for most amateur astronomers. The realization of fully controlling a telescope through a personal computer has been expensive and has required expert knowledge of software and hardware.

The LX200's internal software supports the RS-232 interface, requiring only a serial communication program, such as Procomm. With a serial communication program, you can use the individual commands from the LX200 command set to simulate keypad control functions of the LX200. A simple RS-232 connection to virtually any computer makes all LX200 commands and modes available. You can use a PC to explore the object library, adjust slewing speeds, or adjust focus with the optional #1206 Electric Focuser.

If you are not a professional programmer, but wish to explore remote operation of the LX200 with your computer, there are after-market software programs available specifically for the LX200, including AstroSearch from Meade Instruments Corp.

This appendix provides the following:

- Schematic for constructing your own RS-232 cable
- LX200 TEST program to test the RS-232 communication line
- LX200 command set
- LX200 DEMO, which is a program that you can enter into your computer to access the object library, slew to the object, and center the image

RS-232 Cable

The input hardware uses a standard six-line telephone jack connector, pre-attached to a six-conductor flat line telephone-style cable (of any length, up to 100-feet and perhaps even more, depending on the gauge of the cable). You also need either a nine-pin or 25-pin RS-232 connector, whichever your computer uses for the serial port. All the above items are available at most electronics hardware stores.

Fig. 18 shows the LX200 pinouts for the six-line telephone connector. The table below shows standard IBM-compatible DB-9 and DB-25 serial port pinouts, and how to connect them to the LX200 six-line modular connector.

NOTE:Only 3 wires are required.

LX200 TEST Program

Once you have the RS-232 cable constructed, test it with the following program (LX200 TEST). This program is written in GW Basic programming language; it will work with virtually any IBM-compatible computer. LX200 TEST is an effective program for fully checking RS-232 line communications from your PC to the LX200. It lets you concentrate on debugging your RS-232 cable.

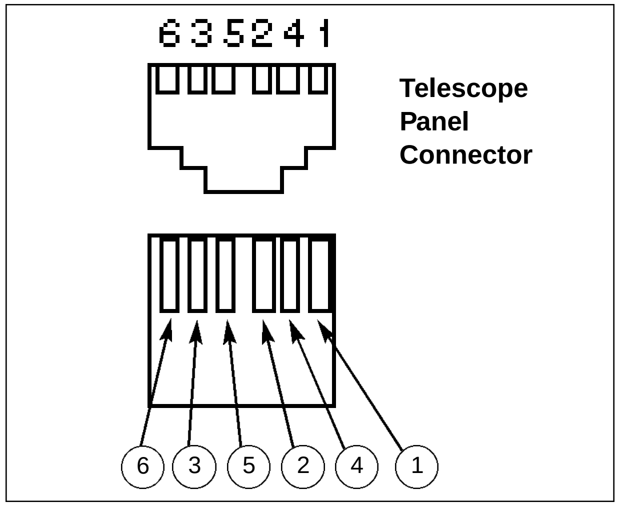

Fig.18: LX200 modular connector.

```
10  CLS
20   DEFINTA-X
30   OPEN   "COM1:9600,N,8,1,CD0,CS0,DS0,RS,"   FOR RANDOM AS #1
50  key1$ = INKEY$: IF key1$ = "" THEN GO TO 50
60  REM KEY1S
70 IF key1$ = CHR$(119) THEN GOSUB 200: REM "w" key
80 IF key1$ = CHR$(101) THEN GOSUB 200: REM "e" key
90 IF key1$ = CHR$(110) THEN GOSUB 200: REM "n" key
100 IF key1$ = CHR$(115) THEN GOSUB 200: REM "s" key
105 IF key1$ = "x" THEN END: REM To exit test.
110 GO TO 50
120 END
200 REM directions
210 REM west
220   IF key1$ = "w" THEN a$ = "#:Mw#": PRINT #1, a$: REM GO west
230 REM east
240   IF key1$ = "e" THEN a$ = "#:Me#": PRINT #1, a$: REM GO east
250 REM north
260   IF key1$ = "n" THEN a$ = "#:Mn#": PRINT #1, a$: REM GO north
270 REM south:
280   IF key1$ = "s" THEN a$ = "#:Ms#": PRINT #1, a$: REM GO south
290 key1$ = INKEY$:
300 IF key1$ = CHR$(32) THEN GO TO 400 ELSE GO TO 200
400 REM  This stops motion (by hitting SPACE bar).
410 B$ = "#:Qe#": PRINT #1, B$
420 B$ = "#:Qw#": PRINT #1, B$
430 B$ = "#:Qn#": PRINT#1, B$
440 B$ = "#:Qs#": PRINT #1, B$
450 RETURN
460 END
```

LX200 RS-232 CONNECTOR PIN OUT CODE LEGEND

6 WIRE MODULAR CONNECTOR	DESCRIPTION	TO DB-9 CONNECTOR PIN#	TO DB-25 CONNECTOR PIN#
#1	+12 VOLTS DC	NOT USED	NOT USED
#2	MISC. SERIALOUT	NOT USED	NOT USED
#3	PC TRANSMIT DATA	#3	#2
#4	GROUND	#5	#7
#5	PC RECEIVE DATA	#2	#3
#6	MISC. SERIALIN	NOT USED	NOT USED

To enter the test program, first load BASIC or GWBASIC (whichever your computer system uses), then type in the LX200 TEST program. When complete, save the program as **LX200TST.BAS**. To use this program, connect the completed cable to your PC serial port and to the LX200 RS-232 port. Load BASIC (or GWBASIC), if it is not already loaded, and run LX200TST.BAS. Nothing will appear on the computer screen. Press any one of the N, S, E, or W (lower case) keys on your PC keyboard, this will move the LX200 North, South, East, or West, respectively. To stop, press the space bar on the PC keyboard. Press **X** to exit the program.

If the LX200 does not respond to the N, S, E, or W keys, be sure the CAPSLOCK is OFF. If it still does not work, check the PC serial port pinouts of your computer to be sure they are wired correctly to the LX200 6-line connector.

With a successful check-out of the PC link with the LX200 using LX200 TEST, you are now ready to write your own software program using the LX200 command set, or to use the sample program called DEMO that is written in Quick Basic software language.

LX200 Command Set

Intended for professional programmers, the LX200 command set is used to write custom software for remote operation of the telescope with a PC. Each command is listed in a section appropriate to its type. Each entry in the command list includes the command name, any parameters, any return values, and a description. The parameters and the return data are shown in a manner that indicates their format. These formats are listed below, along with examples of how the data might actually appear, the legal range of values, and a short description.

1. Command Set Formats

HH:MM.T
Example 05:47.4
Range 00:00.0 - 23:59.9
Hours, minutes, and tenths of minutes.

sDD*MM
Example +45*59
Range -90*00 - +90*00
Signed degrees and minutes (the '' represents ASCII 223, which appears on the handbox as a degree symbol).*

DDD*MM
Example 254*09
Range 000*00 - 359*59
Unsigned degrees and minutes.

HH:MM:SS
Example 13:15:36
Range 00:00:00 - 23:59:59
Hours, minutes, and seconds.

MM/DD/YY
Example 02/06/92
Range 01/01/00 - 12/31/99 (see description)
Month, day, and year. The two digit year indicates the following:
92-99 = 1992-1999
00-91 = 2000-2091

sHH
Example -5
Range -24 - +24
Signed hour offset.

NNNN
Example 3456
Range 0000 - 9999
Four-digit object number.

sMM.M
Example 02.4
Range 05.5 - 20.0
Signed magnitude value.

NNN
Example 134
Range 000 - 200
Three-digit object size (minutes).

DD*
Example 56*
Range 00* - 90*
Higher parameter (degrees).

TT.T
Example 59.2
Range 56.4 - 60.1
Tracking frequency.

<obj> info
Example CNGC1976 SU DNEBMAG 3.9 SZ 66.0'
Range n/a
Object information.

Ok
Example 1
Range 0 or 1
Status value returned after setting values. If the value is legal, 1 is returned, otherwise 0 is returned.

2. General Telescope Information

Command :GR#
Returns +HH:MM.T#
Gets the current R.A.

Command :GD#
Returns sDD*MM#
Gets the current Dec.

Command :GA#
Returns sDD*MM#
Gets the current altitude.

Command :GZ#
Returns DDD*MM#
Gets the current azimuth.

Command :GS#
Returns HH:MM:SS#
Gets the current sidereal time.

Command :SS HH:MM:SS#
Returns Ok
Sets the sidereal time.

Command :GL#
:Ga#
Returns HH:MM:SS#
Gets the local time either in 24-hour (GL) or 12-hour (Ga) format.

Command :SL HH:MM:SS#
Returns Ok
Sets the local time. NOTE: The parameter should always be in 24-hour format.

Command :GC#
Returns MM/DD/YY#
Gets the calendar date.

Command :SC MM/DD/YY#
Returns Ok (see description)
Sets the calendar date. NOTE: After the Ok, if the date is valid, two strings will be sent. The first will contain the message UPDATING PLANETARY DATA, the second (sent after the planetary calculations) will contain only blanks. Both strings will be terminated by the "#"symbol.

Command :Gt#
Returns sDD*MM#
Gets the latitude of the currently selected site.

Command :St sDD*MM#
Returns Ok
Sets the latitude of the currently selected site.

Command :Gg#
Returns DDD*MM#
Gets the longitude of the currently selected site.

Command :Sg DDD*MM#
Returns Ok
Sets the longitude of the currently selected site.

Command :GG#
Returns sHH#
Gets the offset from Greenwich Mean Time.

Command :SG sHH#
Returns Ok
Sets the offset from Greenwich Mean Time.

Command :W1#
:W2#
:W3#
:W4#
Returns Nothing
Sets the current site number.

3. Telescope Motion

Command :Mn#
:Ms#
:Me#
:Mw#
Returns Nothing
Starts motion in the specified direction at the current rate.

Command :MS#
Returns 0, 1, 2, or 4 (see description)
Slews the telescope to current object coordinates. 0 is returned if the telescope can complete the slew, 1 is returned if the object is below the horizon, 2 is returned if the object is below the "higher"limit, and 4 is returned if the object is above the lower limit. If 1, 2, or 4 is returned, a string containing an appropriate message is also returned.

Command :MA#
Returns 0
Slews the telescope to object alt-az coordinates (set with the Sa and Sz commands). This command works only in the LAND and ALTAZ modes.

Command :Qn#
:Qs#
:Qe#
:Qw#
Returns Nothing
Stops motion in the specified direction. Also stops the telescope if a slew to an object is in progress.

Command :Q#
Returns Nothing
Stops a slew to an object.

Command :RG#
:RC#
:RM#
:RS#
Returns Nothing
Sets the motion rate to guide (RG), center (RC), find (RM), or slew (RS).

Command :Sw N#
Returns Ok
Sets the maximum slew rate to N° per second, where N is 2 through 4.

4. Home Position

Command :hS#
Returns Nothing
Starts a home position search and saves the telescope position. NOTE:All commands except ":Q#"and ":h?#"are disabled during the search.

Command :hF#
Returns Nothing
Starts a home position search and sets the telescope position according to the saved values. NOTE: All commands except ":Q#"and ":h?#"are disabled during the search.

Command :hP#
Returns Nothing
Slews the telescope to the home position.

Command :h?#
Returns 0, 1, or 2
Returns the home status:0 if home search failed or not yet attempted, 1 if home position found, or 2 if a home search is in progress.

5. Library/Objects

Command :Gr#
Returns HH:MM.T#
Gets object R.A.

Command :Sr HH:MM.T#
Returns Ok
Sets object R.A.

Command :Gd#
Returns sDD*MM#
Gets object Dec.

Command :Sd sDD*MM#
Returns Ok
Sets object Dec.

Command :Sa sDD*MM#
Returns Ok
Sets object altitude (for MA command).

Command :Sz DDD*MM#
Returns Ok
Sets object azimuth (for MA command).

Command :CM#
Returns (see description)
Sync.Matches current telescope coordinates to the object coordinates and sends a string indicating which object's coordinates were used.

Command :Gy#
Returns GPDCO#
Gets the "type" string for the FIND operation. An upper case letter means that the corresponding type is selected while a lower case letter indicates that it is not.

Command :Sy GPDCO#
Returns Ok
Sets the "type" string for the FIND operation.

Command :Gq#
Returns SU#, EX#, VG#, GD#, FR#, PR#, or VP#
Gets the current minimum quality for the FIND operation.

Command :Sq#
Returns Nothing
Steps to the next minimum quality for the FIND operation.

Command :Gh#
Returns DD*#
Gets the current "higher"limit.

Command :Sh DD#
Returns Ok
Sets the current "higher" limit.

Command :Go#
Returns DD*#
Gets the current "lower" limit.

Command :So DD*#
Returns Ok
Sets the current "lower" limit.

Command :Gb#
:Gf#
Returns sMM.M#
Gets the brighter (Gb) or fainter (Gf) magnitude limit for the FIND operation.

Command :Sb sMM.M#
:Sf sMM.M#
Returns Ok
Sets the brighter (Sb) or fainter (Sf) magnitude limit for the FIND operation.

Command :Gl#
:Gs#
Returns NNN'#
Gets the larger (Gl) or smaller (Gs) size limit for the FIND operation.

Command :Sl NNN#
:Ss NNN#
Returns Ok
Sets the larger (Sl) or smaller (Ss) size limit for the FIND operation.

Command :GF#
Returns NNN'#
Gets the field radius of the FIELD operation.

Command :SF NNN#
Returns Ok
Sets the field radius of the FIELD operation.

Command :LF#
Returns Nothing
Starts a FIND operation.

Command :LN#
Returns Nothing
Finds the next object in a FIND sequence.

Command :LB#
Returns Nothing
Finds the previous object in a FIND sequence.

Command :Lf#
Returns (see description)
Performs a FIELD operation, returning a string containing the number of objects in the field and the object that is closest to the center of the field.

Command :LC NNNN#
:LM NNNN#
:LS NNNN#
Returns Nothing
Sets the object to the NGC (LC), Messier (LM), or Star (LS) specified by the number. Planets are "stars"901-909. The object type returned for LC and LS commands depends on which object type has been selected with the Lo and Ls commands (see below).

Command :LI#
Returns <obj> info#
Gets the current object information.

Command :Lo N#
Returns Ok
Sets the NGC object library type. 0 is the NGC library, 1 is the IC library, and 2 is the UGC library. This operation is successful only if you have a version of the software that includes the desired library.

Command :Ls N#
Returns Ok
Sets the STAR object library type. 0 is the STAR library, 1 is the SAO library, and 2 is the GCVS library. This operation is successful only if the user has a version of the software that includes the desired library.

6. Miscellaneous

Command :B+#
:B-#
:B0#
:B1#
:B2#
:B3#
Returns Nothing
Increases (B+) or decreases (B-) reticle brightness, or sets to one of the flashing modes (B0, B1, B2, or B3).

Command :F+#
:F-#
:FQ#
:FF#
:FS#
Returns Nothing
Starts focus out (F+), starts focus in (F-), stops focus change (FQ), sets focus fast (FF), or sets focus slow (FS).

Command :GM#
:GN#
:GO#
:GP#
Returns XYZ#
Gets SITE name (XYZ). M through N correspond to 1 through 4.

Command :SM XYZ#
:SN XYZ#
:SO XYZ#
:SP XYZ#
Returns Ok
Sets SITE name.

Command :GT#
Returns TT.T#
Gets the current track "frequency."

Command :STTT.T#
Returns Ok
Sets the current track "frequency."

Command :TM#
:TQ#
:T+#
:T-#
Returns Nothing
Switch to manual (TM) or quartz (TM). Increment (T+) or decrement (T-) manual frequency by one tenth.

Command :D#
Returns (see description)
Gets the distance "bars""string.

Command :AL#
:AP#
:AA#
Returns Nothing
Sets the telescopes alignment type to LAND, POLAR, or ALTAZ.

Command :r+#
:r-#
Returns Nothing
Turns the field de-rotator on (:r+#) and off (:r-#).

Command :f+#
:f-#
Returns Nothing
Turns the fan on (:f+#) and off (:f-#).

LX200 Demo Program

The RS-232 interface communicates with your computer at 9600 baud rate, parity = None, 8 data bits, 1 stop bit. For those who are familiar with programming, the LX200 command set is written in ASCII-character format; you can use it to write your own programs.

The LX200 Demo Program on the following pages is written in Quick Basic. It is intended to demonstrate how commands are sent to the telescope and how information is received from the telescope. It is not a polished program; it does not incorporate all the RS-232 features available.

The LX200 Demo Program is set up to operate on serial port 2 (COM2:). To operate on serial port 1 (COM1:), change line 4 from COM2: to COM1:.

Meade Instruments does not support these programs, or programs that you may write, in any way. For questions relating to after-market software programs, refer to the respective manufacturers. Meade recommends and supports our Epoch 2000sk software package (Fig. 19). This software is fully compatible with the 16” LX200 telescope.

The LX200 Demo Program presents an incredibly detailed simulation of the entire sky, including up to 281,000 celestial objects, on the display of a personal computer .

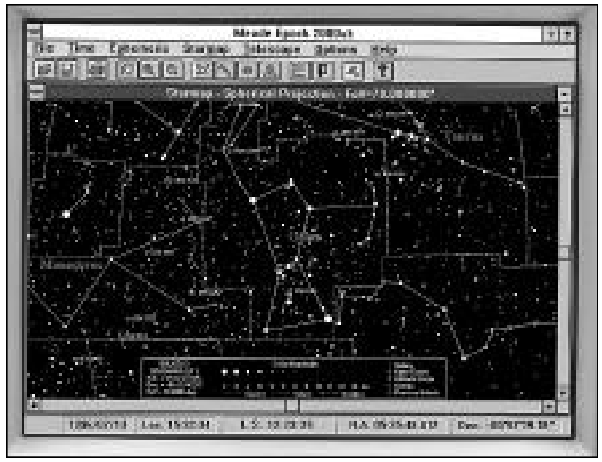

Fig.19: Epoch 2000sk software.

Epoch 2000 allows the presentation of the most complex starfields, as they appear through the telescope. This software is available for Windows 3.1 or higher, including Windows 95.

The program follows.

```
CLS

DEFINTA-X
counter = 0
OPEN "COM2:9600,N,8,1,CD0,CS0,DS0,OP0,RS,TB2048,RB2048" FOR RANDOM AS #1

KEY ON
KEY(1) ON
        KEY 1, "GO TO":
        ON KEY(1) GOSUB key1
KEY(2) ON
        KEY 2, "SYNC"
        ON KEY(2) GOSUB KEY2
KEY(3) ON
        KEY 3, "SLEW"
        ON KEY(3) GOSUB key3
KEY(4) ON
        KEY 4, "FIND"
        ON KEY(4) GOSUB KEY4
KEY(5) ON
        KEY 5, "CNTR"
        ON KEY(5) GOSUB KEY5
KEY(6) ON
        KEY 6, "GUIDE"
        ON KEY(6) GOSUB KEY6
KEY(11) ON
        ON KEY(11) GOSUB key11
KEY(12) ON
        ON KEY(12) GOSUB key12
KEY(13) ON
        ON KEY(13) GOSUB key13
KEY(14) ON
        ON KEY(14) GOSUB key14

    GOSUB status
    GOSUB key3
    GOSUB help
20 GOSUB telpos
    GOSUB OBDRAW
    GOSUB TIME
50 key$ = INKEY$: IF key$ = "" THEN GO TO 20
```

```
REM KEYS
  IF key$ = CHR$(119) THEN GOSUB senddir: REM  a$ = "#:Mw#"
  IF key$ = CHR$(101) THEN GOSUB senddir: REM  a$ = "#:Me#"
  IF key$ = CHR$(110) THEN GOSUB senddir: REM  a$ = "#:Mn#"
  IF key$ = CHR$(115) THEN GOSUB senddir: REM  a$ = "#:Ms#"
  IF key$ = "m" THEN GOSUB objects
  IF key$ = "t" THEN GOSUB objects
  IF key$ = "c" THEN GOSUB objects
  IF key$ = "p" THEN GOSUB objects
  IF key$ = "x" THEN CLS : END
  IF key$ = "r" THEN RUN

GO TO 20

END

senddir:
west:
    IF key$ = "w" THEN a$ = "#:Mw#": PRINT #1, a$: REM GO TO west
east:
    IF key$ = "e" THEN a$ = "#:Me#": PRINT #1, a$: REM GO TO east
north:
    IF key$ = "n" THEN a$ = "#:Mn#": PRINT #1, a$: REM GO TO north
south:
    IF key$ = "s" THEN a$ = "#:Ms#": PRINT #1, a$: REM GO TO south
    GOSUB telpos
    key$ = INKEY$:
    IF key$ = CHR$(32) THEN GO TO end1 ELSE GO TO senddir
end1:
  B$ = "#:Qe#": PRINT #1, B$
  B$ = "#:Qw#": PRINT #1, B$
  B$ = "#:Qn#": PRINT #1, B$
      B$ = "#:Qs#": PRINT #1, B$
          RETURN
```

```
telpos:
        LOCATE 6, 7: PRINT "TELESCOPE POSITION";
        c$ = "#:GR#": PRINT #1, c$; : d$ = INPUT$(8, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 4, 4): LOCATE 7, 10: PRINTUSING "RA: \\:\  \"; RAL$; RAM$;
        c$ = "#:GD#": PRINT #1, c$; : d$ = INPUT$(7, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 5, 2): LOCATE 8, 10: PRINT "DEC: "; RAL$; CHR$(248); RAM$; "'";
        c$ = "#:GA#": PRINT#1, c$; : d$ = INPUT$(7, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 5, 2): LOCATE 9, 10: PRINT "ALT: "; RAL$; CHR$(248); RAM$; "'";
        c$ = "#:GZ#": PRINT #1, c$; : d$ = INPUT$(7, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 5, 2): LOCATE 10, 10: PRINT"AZ : "; RAL$; CHR$(248); RAM$; "'";
        RETURN
TIME:
        LOCATE 1, 32: PRINT"DATE"; : LOCATE 1, 64: PRINT "TIME";
        c$ = "#:GS#": PRINT #1, c$; : d$ = INPUT$(9, 1): RAL$ = LEFT$(d$, 2):
            RAM$ = MID$(d$, 4, 2):  RAR$ = MID$(d$, 7, 2): LOCATE 2, 55:
        PRINT USING "Sidereal Time: \\:\\:\\"; RAL$; RAM$; RAR$;
        c$ = "#:GL#": PRINT #1, c$; : d$ = INPUT$(9, 1): RAL$ = LEFT$(d$, 2):
            RAM$ = MID$(d$, 4, 2):  RAR$ = MID$(d$, 7, 2): LOCATE 3, 55:
        PRINT USING "Local (24hr) : \\:\\:\\"; RAL$; RAM$; RAR$;
        c$ = "#:GG#": PRINT #1, c$; : d$ = INPUT$(4, 1): RAL$ = LEFT$(d$, 3):
            LOCATE 3, 25: PRINT USING "GMT Offset: \  \ Hours"; RAL$;
        c$ = "#:GC#": PRINT #1, c$; : d$ = INPUT$(9, 1): RAL$ = LEFT$(d$, 2):
            RAM$ = MID$(d$, 4, 2):  RAR$ = MID$(d$, 7, 2): LOCATE 2, 25:
        PRINT USING "Date       :  \\/\\/\\"; RAL$; RAM$; RAR$;
    RETURN

objects:
        counter = 1
        LOCATE 21, 25
        IF key$ = "m" THEN INPUT"Enter Messier number: "; m$: o$ = "#:LM" + m$
        IF key$ = "t" THEN INPUT "Enter Star number: "; m$: o$ = "#:LS" + m$
        IF key$ = "c" THEN INPUT "Enter CNGC number: "; m$: o$ = "#:LC" + m$
        IF key$ = "p" THEN INPUT "Enter Planet number: "; m$: o$ = "#:LS" + m$
        o$ = o$ + "#"
        PRINT #1, o$
        LOCATE 21, 15:
        PRINT "                                        ";
        PRINT #1, "#:LI#": info$ = INPUT$(33, 1): REM LOCATE 10, 20: PRINT info$;
OBDRAW:
        LOCATE 6, 31: PRINT "    O B J E C T   I N F O R M A T I O N";
        LOCATE 7, 31: PRINT"Object:     "; LEFT$(info$, 9);
        LOCATE 8, 31: PRINT "Rating:     "; MID$(info$, 10, 7);
        LOCATE 9, 31: PRINT "Magnitude:   "; MID$(info$, 20, 5);
        LOCATE 10, 31: PRINT"Size:        "; MID$(info$, 27, 6);
        IF counter = 0 THEN LOCATE 11, 31: PRINT "RA:"; : LOCATE 12, 31:
            PRINT "DEC:"; : LOCATE 7, 60: PRINT "Distance to SLEW"; :
        LOCATE 9, 55: PRINT"RA"; : LOCATE 10, 55: PRINT"Dec"; : GO TO scale
        c$ = "#:Gr#": PRINT #1, c$; : d$ = INPUT$(8, 1): RAL$ = LEFT$(d$, 2):
            RAM$ = MID$(d$, 4, 4): LOCATE 11, 31:
        PRINT USING "RA:         \\:\  \"; RAL$; RAM$;
        c$ = "#:Gd#": PRINT #1, c$; : d$ = INPUT$(7, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 5, 2): LOCATE 12, 31:
        PRINT "DEC:         "; RAL$; CHR$(248); RAM$; "'";
distbar:
        rad$ = "": decd$ = ""
        c$ = "#:D#": PRINT #1, c$: d$ = INPUT$(33, 1)

        FOR i = 1 TO 16
        IF ASC(MID$(d$, i, 1)) = 255 THEN rad$ = rad$ + CHR$(254)
        NEXT i
        FOR i = 17 TO 33
        IF ASC(MID$(d$, i, 1)) = 255 THEN decd$ = decd$ + CHR$(254)
        NEXT i
        LOCATE 7, 59: PRINT " Distance to SLEW  ";
scale:
        LOCATE 8, 59: PRINT "0"; CHR$(248); " 45"; CHR$(248); "  90"; CHR$(248); "   150+";         CHR$(248);
IF counter = 0 THEN RETURN
        LOCATE 9, 55: PRINT "                    "; : LOCATE 9, 55:
        PRINT  "RA  "; rad$;
        LOCATE 10, 55: PRINT "                    "; : LOCATE 10, 55:
        PRINT "DEC "; decd$;
RETURN
```

```
status:
        LOCATE 1, 7: PRINT "SITE"
        c$ = "#:Gt#": PRINT#1, c$; : d$ = INPUT$(7, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 5, 2): LOCATE 2, 3: PRINT "Lat. : "; RAL$; CHR$ (248); RAM$; "'";
        c$ = "#:Gg#": PRINT#1, c$; : d$ = INPUT$(7, 1): RAL$ = LEFT$(d$, 3):
            RAM$ = MID$(d$, 5, 2): LOCATE 3, 3: PRINT "Long.: "; RAL$; CHR$ (248); RAM$; "'";
        BOXSTX = 2: BOXSTY = 3: BOXWIDE = 10: boxtall = 5: GOSUB drawbox
        RETURN

key1:
        PRINT #1, "#:MS#"
        error1$ = INPUT$(1, 1)
        IF error1$ = "1" OR error1$ = "2" THEN error2$ = INPUT$(33, 1) ELSE RETURN
        LOCATE 22, 20: PRINTerror2$

        GOSUB clearscr
        RETURN
KEY2:
        PRINT #1, "#:CM#"
        sync$ = INPUT$(33, 1)
        LOCATE 22, 20: PRINT sync$;
clearscr:
        FOR i = 1 TO 30000: NEXT i: FOR i = 1 TO 30000: NEXT i: FOR i = 1 TO 30000: NEXT i:
        FOR i = 1 TO 30000: NEXT i: FOR i = 1 TO 30000: NEXT i: FOR i = 1 TO 30000: NEXT i:
        LOCATE 22, 20: PRINT "                                                            ";
RETURN

key3:
        PRINT #1, "#:RS#"
        LOCATE 24, 1: PRINT "
                                        ";
        LOCATE 24, 18: PRINT CHR$(219); CHR$(178); CHR$(176); CHR$(176); CHR$(178); CHR$(219);
RETURN

KEY4:
        PRINT #1, "#:RM#:"
        LOCATE 24, 1: PRINT "                          ";
        LOCATE 24, 26: PRINT CHR$(219); CHR$(178); CHR$(176); CHR$(176); CHR$(178); CHR$(219);
RETURN
KEY5:
        PRINT #1, "#:RC#"
        LOCATE 24, 1: PRINT "
            ";
        LOCATE 24, 34: PRINTCHR$(219); CHR$(178); CHR$(176); CHR$(176); CHR$(178); CHR$(219);
RETURN
KEY6:
        PRINT #1, "#:RG#"
        LOCATE 24, 1: PRINT "
            ";
        LOCATE 24, 42: PRINT CHR$(219); CHR$(178); CHR$(176); CHR$(176); CHR$(178); CHR$(219);
RETURN

key11:
        key$ = "n"
        GOSUB north
        RETURN
key12:
        key$ = "w"
        GOSUB west
RETURN

key13:
        key$ = "e"
        GOSUB east
        RETURN
key14:
        key$ = "s"
        GOSUB south
RETURN
```

```
drawbox:
REM         LOCATE BOXSTX, BOXSTY:
REM         BOX$ = CHR$(201)
REM         FOR I = 1 TO BOXWIDE: BOX$ = BOX$ + CHR$(205): NEXT
REM         PRINT BOX$;
RETURN

help:
        LOCATE 14, 10: PRINT "E W N S keys move telescope. SPACE BAR stops.";
        LOCATE 15, 10: PRINT "M key to enter Messier object.";
        LOCATE 16, 10: PRINT"T key to enter sTar.";
        LOCATE 17, 10: PRINT "P key to enter Planet (900 + orbit #).";
        LOCATE 18, 10: PRINT "C key to enter Cngc object.";
        LOCATE 19, 10: PRINT "X to End program.";
RETURN

        END
```

APPENDIX F:
LX200 SPECIFICATIONS

Telescope	**16"LX200 f/10**
Optical Design	Schmidt-Cassegrain Catadioptric
Clear Aperture	406mm (16")
Primary Mirror Diameter	415.9mm (16.375")
Focal Length	4064mm (160")
Focal Ratio	f/10
Resolution	28 arc sec
Super Multi-Coatings	Standard
Limiting Visual Magnitude (approx)	15.5
Limiting Photographic Magnitude (approx)	18.0
Image Scale (°/inch)	0.36°/inch
Maximum Practical Visual Power	800X
Near Focus	100'
Optical Tube Size	17.5" Dia. x 33" Long
Secondary Mirror Obstruction	5.0" (9.8%)
Telescope Mounting	Heavy-Duty Fork-Type One-piece
Setting Circle Diameters	Dec.: 12"; R.A.: 17"
RAMotor Drive System	4-Speed, microprocessor controlled 18v. DC servo motor; 11.0" worm gear with Smart Drive
Hemispheres of Operation	North and South - switchable
Declination (Dec.) Control System	4 speed, DC servo controlled 11.0" worm gear with Dec drift software & Smart Drive
Motor Drive Gear Diameter	11.0" Worm Gear
Manual Slow-Motion Controls	Dec. and R.A.
Hand Controller	Motorola 68HC05 microcontroller; 2 line x 16 alphanumeric character display; 19 button keypad, red LED backlit
Main Controller microprocessor; volatile	16 MHz 68301 1 Meg program memory ; 64K RAM; 4096 byte non- memory (EEROM)
Telescope Size, Swung Down	18" x 26" x 51"
Maximum Slew Speed	4° per Second
35mm Angular Film Coverage	0.49° x 0.34°
35mm Linear Film Coverage @:	
50'	3.1" x 4.4"
500'	3.0" x 4.3"
3000'	18.0' x 25.5'
Tele-Extender Used Without Eyepiece @:,	
50'	2.9" x 4.3"
500'	2.5' x 3.6'
3000'	15.5' x 22.5'
Carrying Case Dimensions	N/A
Net Telescope Weights (approx)	
Telescope	215#
Optional Equatorial Wedge	N/A
Optional Super Wedge	N/A
Field Tripod	90#
Accessories	8#
Shipping Weights (approx)	
Telescope	250#
Equatorial Wedge (optional)	N/A
Super Wedge (optional)	N/A
Field Tripod	95#
Accessories	10#

NOTE: All Meade telescopes are under continuous technical review; specifications may change without notice. We reserve the right to ship our latest models.

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