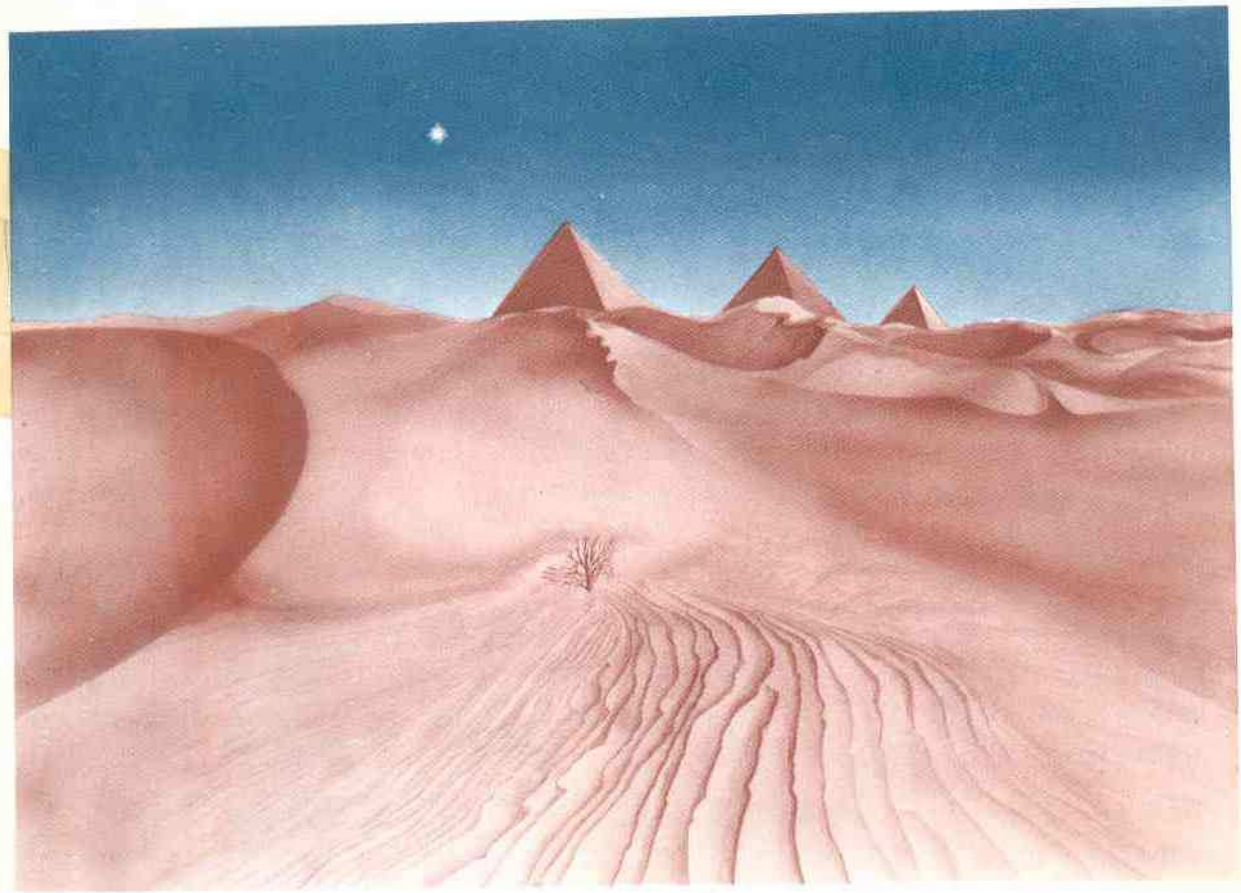
Star and Telescope

Reach into
Universe with
Your Telescope

Telescope Manual

INDEX



As the evening sun sets in the western sky, the stars begin to enact a beautiful drama on the dark screen overhead. Looking up at the night sky, ancient peoples, giving play to their imagination, spoke to the stars. About 5,000 years ago, Mesopotamean shepherds named the constellations, when they saw groups of bright stars apparently forming patterns, and likened these patterns to the gods and animals of the Greeks and Romans.

We now live in an age of science, and we will soon be able to travel in spaceships throughout the universe. However, the importance of telescopes will never decrease because they are good guides to the universe.

Did you assemble your telescope correctly? If you did, let's start our observations. You may be disappointed at a dim image.

Various causes can be responsible for this, but if your telescope is made correctly and you obye the following rule, you will never experience this kind of problem. A patient, persevering attitude is most important when you carry out telescopic observations.

As a beginner, you should start by observing the moon, the heavenly body nearest to us. Since it is some 380,000 km away from the earth, however, you should remember that it will take beginners one-half to one hour to focus thcir telescopes perfectly on the moon.

The first time you see the moon in your telescope it will be so beautiful that you will gasp in admiration, and will never be able to forget it.

OBJECTS TO BE OBSERVED, AND PROPER ASTRONOMICAL TELESCOPE MAGNIFICATIONS

MERCURY

Mercury, nearest to the sun, cannot be located unless the conditions of observation are unusually good. Suitable magnification: 100x.

JUPITER

Use of a magnification of 40x allows observation of the well-known moon "Galileo". You should observe and record the movements of the moon. Observation of the light and dark belts on Jupiter requires both careful attention and clearness of the atmosphere. Suitable magnifications: 80 x~100 x.

SATURN

The rings of Saturn, which are a spectacle unique in all the heavens, can be observed with 60x magnification. Observation of the elliptical shape and bands of the planet itself requires the use of minimum of 100x magnification. Occasionally, the rings cannot be seen, because of their inclination.

MULTIPLE STARS

Some stars seem single to the unaided eye but prove to be composed of two, three or more stars under telescopic observation. Double stars consist of two component stars, and triple stars are composed of three stars. Mizar at the curve in the Big Dipper's handle and Albireo at the head of Cygnus (this star is said to have the most beautiful color in all the heavens) are representative double stars. Use of a comparatively low magnification about 40x is suitable.

NEBULAE AND STAR CLUSTERS

The Great Nebula in Orion's sword and the Great Spiral Nebula in Andromeda can be seen with the unaided eye. When you observe nebulae and star clusters, it is recommended that you use a telescope with the largest possible aperture at the smallest magnification.

THE SUN

Use of a 40mm aperture telescope is adequate for sunspot observation, but continuous observation of the sun requires the use of a 60mm aperture refractor. In any case, use of approx. 60x magnification is recommended for viewing the whole image of the sun in the field. Observation of the sun should be carried out during the two hours starting from 9 am since the calm atmospheric conditions during this period cause very little image distortion. When the atmospheric conditions are especially good, the sun's granulations may come into view.

THE MOON

Though telescopes with any aperture diameters and magnifications can be used in observing the moon, adequate total images can be obtained by the use of a telescope with 45x to 60x magnification. Viewing a full moon does not permit the craters to be seen clearly, and gives only flat images. During the few days before and after a full moon, beautiful images of the craters can easily be seen.

VENUS

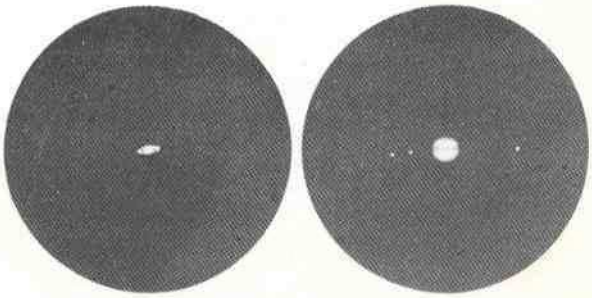
Venus, which is so bright that it is called the "Morning Star" or "Evening Star," is totally covered with a dense atmosphere. Since no belts can be seen, observation should center on the sketching of the moon-like waning and waxing of planet. Suitable magnification: 40x.

MARS

Mars comes close to the earth every 26 months. Observation of Mars is comparatively difficult. Use of a telescope with an aperture diameter of 100mm or more and with a magnification of 100x permits observation of the polar cap.

TELESCOPIC VIEWS OF PLANETS

Beginning astronomers tend to feel that the planet as seen through the telescope is much smaller than they expected. The two photos below show how planets appear when they are observed with a small 60mm, 50x telescope which can be bought easily at department stores.



THE MOON VIEWED TELESCOPICALLY

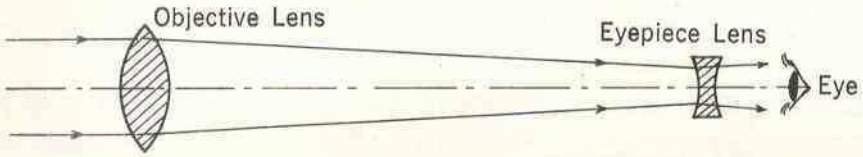
Small aperture

Large aperture

Telescopes with the same magnification but different resolving powers give different image detail. As shown in the above photos, telescopes with larger aperture diameters give more detailed, fine-structured images.

TYPES OF TELESCOPES AND OPTICAL SYSTEM

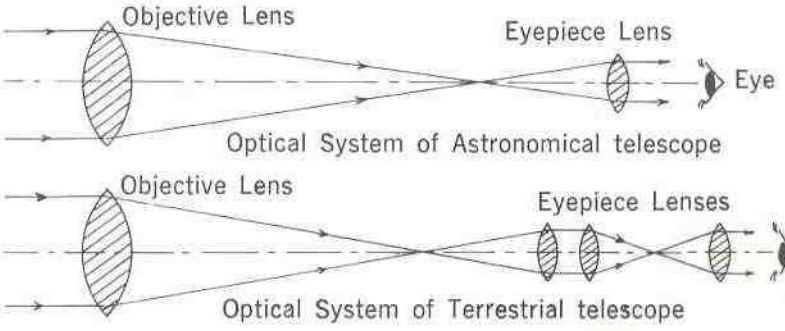
Over three centuries ago, Galileo Galilei turned a tiny telescope toward the stars and the modern Age of Science began. There are two general classes of telescopes: terrestrial telescopes and astronomical telescopes. The primary difference is that the terrestrial telescope, which is intended for viewing objects on the earth, gives an upright or normal image, whereas the astronomical telescope gives an inverted or upside-down image. While it's important to be able to view things in their normal position for earth-bound objects, this is not important for astronomical viewing.



Optical Systen of Galileo's Telescope

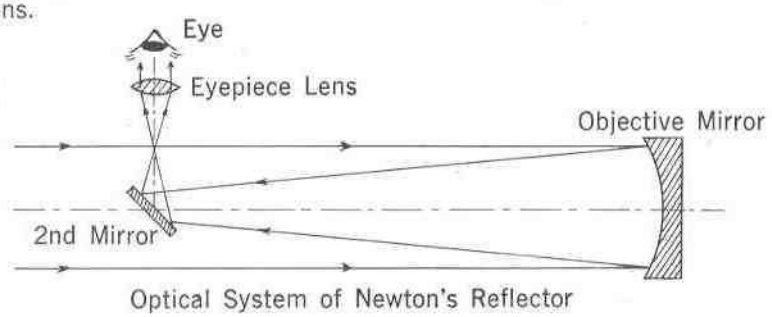
The reason astronomical telescopes generally show an inverted image is because they do not have the extra inverter lens system normally found in terrestrial telescopes. Although the additional lens system gives an up-right image, it also causes a slight loss of light. In an astronomical telescope, which is used on extremely faint objects, it is important to keep the light loss to a minimum. This does not mean that terrestrial telescopes cannot be used for astronomical viewing. They just won't be able to show as faint an object as a comparable astronomical telescope.

REFRACTOR TELESCOPE



Astronomical telescopes are further divided into two other categories, depending on the optical system used. The refractor uses only lenses to magnify, whereas the reflector employs a mirror in place of the objective lens.

REFLECTOR TELESCOPE



EYEPIECE AND MAGNIFICATION OF TELESCOPE

The power or magnification of a telescope, whether it be reflector or refractor, is determined by the focal lengths of the objective lens and the eyepiece lens. Focal length is the distance from the lens at which a sharp or in-focus image is formed. The focal length of the objective lens is usually quite long compared to the focal length of the eyepiece lens. If you divide the focal length of the objective lens (or mirror) by the focal length of the eyepiece the result will be the magnification of the telescope. Most astronomical telescope employ different focal length eyepiece for different power..... the shorter focal length eyepieces giving greater magnifications. The power of each particular eyepiece is directly related to the focal length of the objective mirror or lens in the telescope..... which is temporary 800mm.

The formula is as follows:

$$\frac{\text{Focal length of objective lens (Mirror)}}{\text{Focal length of eyepiece}} = \text{Magnification}$$

As an example, your H-12.5mm eyepiece will show a magnification of:

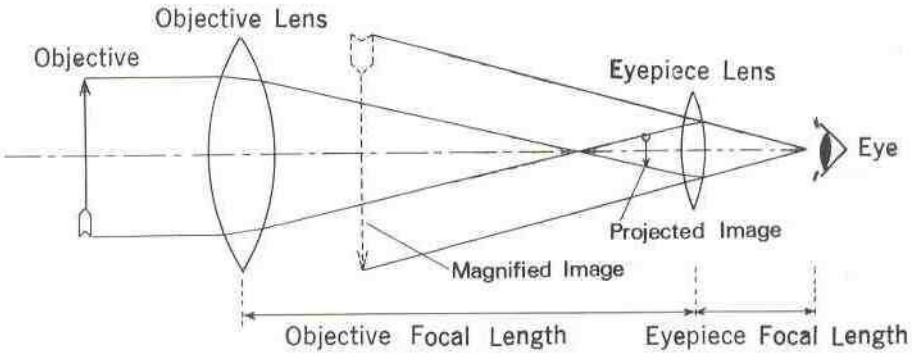
$$\frac{800\text{mm}}{\text{H-12.5mm}} = 64\text{X Magnification}$$

Using the same formula, the another eyepiece will give:

H-20mm ..... 40X Magnification

The eyepiece may be inserted into the eyepiece adapter which may by turning the fine focusing knob. The letter H on the eyepiece is the abbreviation of Huygen Type, a type of eyepiece, and HM; Huygen Mittenzwey, OR; Orthoscopic, SR; Special Ramsden, AH; Achromatic Huygen respectively. The number beside the letter denotes the focal length of the eyepiece. If you approach the eye too closely to the eyepiece, it may be made dirty by the eyelashes or eyelid, or obscured by your breath. In such case you should wipe the eyepiece with soft cloth carefully.

HOW A TELESCOPE WORKS



THE PERFORMANCES OF ASTRONOMICAL TELESCOPES

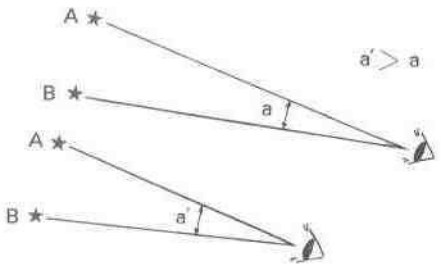
There are some who ask the question "what is the magnification of this telescope?" This is not very sensible. It is not the magnification that determines the performance of a telescope. Its performance depends on the effective diameter of its objective lens. The greater the effective diameter, the better the performance, which may be expressed in terms of the resolving power, condensing power, limiting magnitude, and the like.

RESOLVING POWER

Two stars that are located very close to each other may appear to be a single star as observed by the naked eye, whereas they can be identified separately by a telescope. In the same way, two stars that appear to be a single star as observed by a telescope with a smaller objective lens can be identified separately by a telescope with a large objective lens.

The minimum distance between two bodies that allows a telescope to identify them separately is referred to as the resolving power. This distance is expressed as an angle, i.e., __'__". Any two bodies with a distance greater than this minimum angle can be identified separately.
The smaller the angle value, the better the telescope.

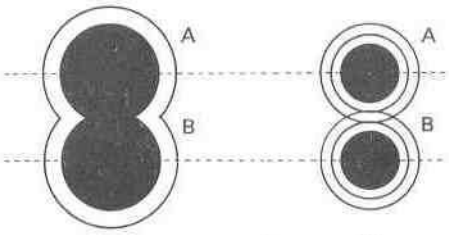
The apparent distance between A and B is expressed as angle a or a'.



The nearer the observation point, the larger the same actual distance between two points appears. The distance between celestial bodies as observed from the earth is expressed as an apparent distance.

DOUBLE STARS OBSERVED BY TELESCOPES

The fixed stars appear smaller and more sharply defined when observed by the larger telescope.



Small caliber Large caliber

The same double stars will appear overlapped if the observation is made by a telescope of poor resolving power.

CONDENSING POWER

How much light can it condense as compared with the human eye?

As light enters the eye through the pupil, it may be condensed according to the area of the pupil. In this way, as it enters the telescope through the objective lens, it may be condensed according to the area of the objective lens. Therefore, the condensing power is determined by the formula:

area of objective lens ÷ area of pupil.

Namely,

condensing power = (effective diameter of objective)^2 ÷ (pupil diameter)^2 = (effective diameter of objective lens)^2 ÷ 7^2

Since the human pupil normally opens to 7mm in the dark, the diameter of the pupil is taken as 7mm. The greater the condensing power, the better the telescope.

With great condensing power, stars invisible to the naked eye are made observable.

LIMITING MAGNITUDE

Up to which magnitude of stars can it make observable?

In the order of descending brightness, stars are classified into -2 magnitude, -1 magnitude, 0 magnitude, 1 magnitude, 2 magnitude, and so forth. For example, Sirius, the brightest star among fixed stars, is of -1.6 magnitude, the polestar of 2.1 magnitude, the full moon of -12.5 magnitude, and the sun of -26.7 magnitude.

The dimmest stars visible to the human eye are normally of 6 magnitude. Since telescopes more greatly condense the light coming from stars than does the eye, they can make stars dimmer than the ones just mentioned visible. Therefore the larger the telescope, the more stars become observable. When stars of up to 10 magnitude are made observable by a telescope, the limiting magnitude of this telescope is expressed as 10 magnitude. The larger the limiting magnitude, the better it is.

THE MOUNTING AS A STAGE

Since astronomical telescopes are high in magnification and heavy in weight, it is very difficult to bring a star into the field of view if the observation is made by supporting a telescope by hand. Even if the star is once caught, it will soon go away. The mounting is a stage to support the body tube and has the following three functions:

1. To catch readily and surely the star to be observed.
2. To prevent the star image from swinging during observation.
3. To move the body tube so as to follow the traveling star.

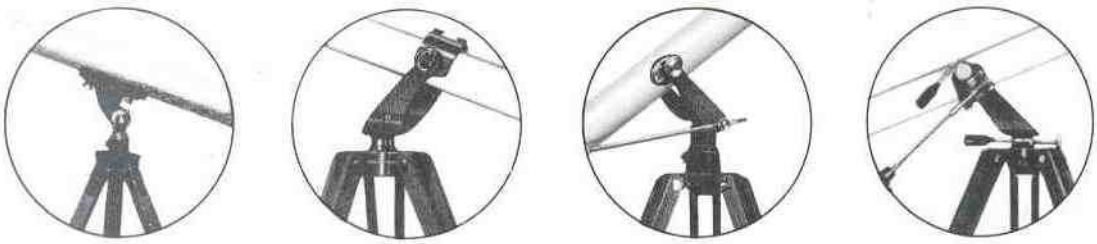
Depending on the method of moving the body tube, the mounting may be classified as the theodolite stage or the equatorial.

THE THEODOLITE STAGE (ALT-AZIMUTH MOUNT)

This is a stage that allows the body tube to move in two directions, vertical and horizontal. Any star, wherever it may be located, may be caught or followed freely by movement in the two directions.

Stars travel the sky slowly. A device that moves the body tube gently and smoothly to follow the slow movement of stars is called the fine adjustment. Some theodolite stages, however, are not provided with the fine adjustment.

KIND OF THE THEODOLITE STAGE

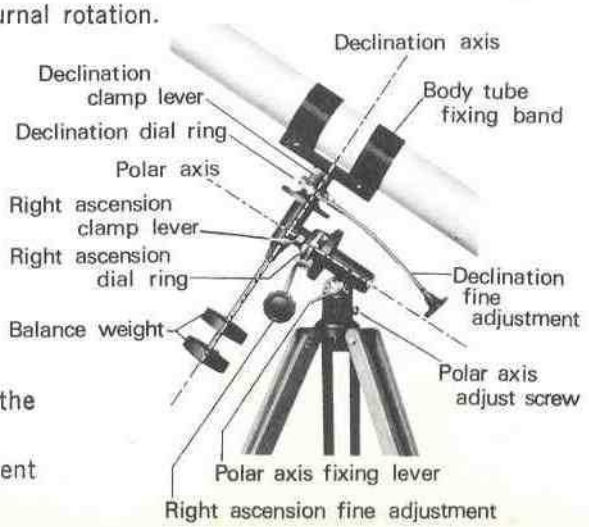


THE EQUATIAL STAGE

Stars travel through a full circle every day, taking the polestar as the center. This movement is referred to as the diurnal rotation of stars. The equatorial represents a stage that allows the body tube to move along the direction of this diurnal rotation.

The equatorial stage is provided with two axes, the polar and the declination, and is movable in the direction of diurnal rotation (the direction of right ascension), taking the polar axis as the center, and in the direction of south-north (the direction of declination), taking the declination axis as the center as well. Thus, provided that the equatorial is set correctly, any star once brought into the field of view may be followed simply by turning the polar axis.

Most equatorials are provided with a fine adjustment for both of the polar and the declination axis.



HOW TO HANDLE THE EQUATORIAL

The equatorial offers a convenient means of following the movement of stars. Unless it is assembled or set correctly, however, it will be rather inconvenient to handle as compared with the theodolite stage. Please bear the following in mind whenever you use the equatorial:

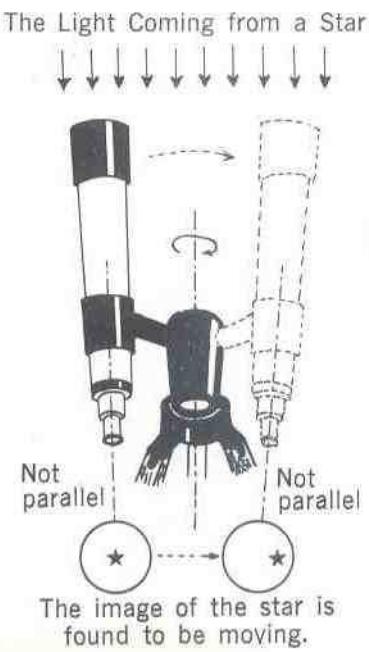
1. Keep the telescope in a good balance in relation to the polar and declination axes.
2. Set the polar axis correctly to the celestial north pole.
3. Take care that the polar axis, once set, does not move during the observation.

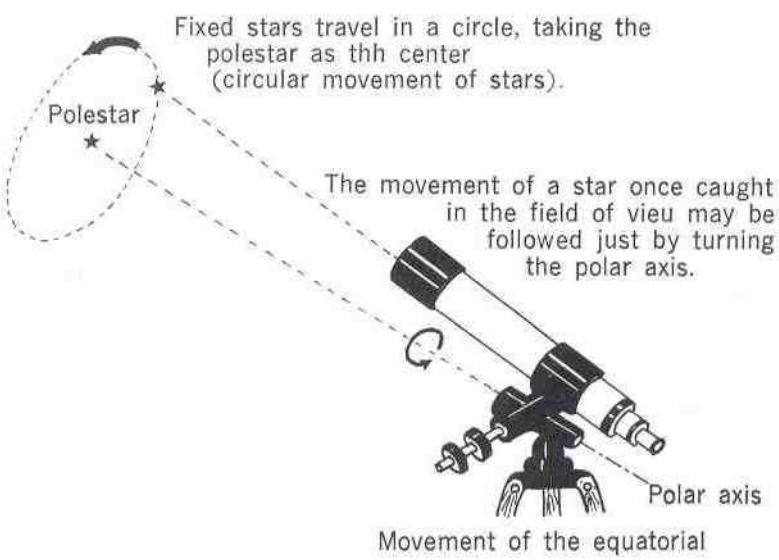
HOW TO SET THE POLAR AXIS

Apart from taking celestial photographs that require a considerable time, it is sufficient in an ordinary observation if the polar axis is set to the polestar.

1. Adjust the balance of the body tube. The balance may be adjusted by moving the balance weight in relation to the polar axis and by moving the telescope back and forth in relation to the declination axis. Whenever a camera or the like is attached, readjust the balance.
2. Set the polar axis to the north at a site where the polestar is seen. The inclination of the polar axis is set roughly to match the latitude of the site.
3. Keep the polar axis and body tube parallel. This may be done mainly by moving the body tube until the declination dial points to 90°. Then, order to make them exactly parallel, bring a star located close to the North Pole into the field of view and turn the body tube to the left and right up to an angle of some 90° around the polar axis. Unless the star has then moved from the field of view, the polar axis and body tube are considered to be parallel.
4. Set the inclination and horizontal angles of the polar axis while taking care that the parallel between the polar axis and body tube is not disturbed. The horizontal angle of the polar axis may be adjusted by turning the polar axis stage or by shifting the entire arrangement, including the footings.

When the polar axis and body tube are not parallel, the light enters straight at the position of A', but diagonally at the position of B'.





BEST USE OF THE TELESCOPE

Since astronomical telescopes are high in magnification and narrow in field of view, it is rather difficult to catch a particular star among a great number of stars and to follow its movement. The crux of succeeding in the observation is to master the use of an astronomical telescope.

HANDLING

Do not handle the telescope violently. In particular, when the body tube is carried, be sure not to bump or drop it.

ASSEMBLING

If the star is difficult to catch and, when caught, is swinging and hardly observable, this is most often due to poor assembly of the telescope.

1. Check closely to make sure that the clamp screws of the footings as well as the screws of the stage are kept tight.
2. Adjust the balance of the body tube so that its front and rear parts are equalized in weight.

OBSERVATION SITE

Since it takes considerable time to observe a star, the telescope should be set at a properly selected site.

1. Select an open site where light is at a minimum and the largest possible celestial area can be seen.
2. Select a flat site where there is no unevenness or stones. Take care not to stumble and damage the telescope.
3. Place such parts as the eyepiece on the triangle plate, or keep them in a small box.

ADJUSTMENT OF THE FINDER

The finder is a telescope of small size and magnification that is attached to the body tube and functions to catch easily and quickly the star to be observed. Unless the same star is seen by both telescope and finder, it is difficult to catch it in the telescope.

1. With the telescope, a bright neon sign or lamp distant by more than 1,000 meters.
2. Watch the finder, and if the same image seen at the center of tha telescope is found at the center of its field of view without moving the telescope, it is unnecessary to adjust the finder.
3. If the same image is not formed at the center of the field of view, bring the image to the center by moving the adjustment screws attached to the footings of the finder. If one of the screws is loosened, be sure to tighten it and all the others firmly.

HOW TO ADJUST THE FOCUS

Although it appears easy to adjust the focus, it is rather laborious in practice until one gets used to it. Focus on any distant image in the daytime and repeat this practice to develop skill in it.

1. Adjust the focus by moving the drawtube back and forth. This may be done by turning the focusadjusting handle, or by hand in case no handle is attached.
2. Since stars are always moving, focus on a neon sign or lamp over 1,000meters away. When the image is focused roughly, adjust the focus by moving the drawtube back and forth slightly until the image is made clear. Then, without shifting the tube, point it to catch a star, and the focus will normally be found to be correct.
3. First adjust the focus with an eyepiece of lower magnification and then change it to another

one having the required magnification.

4. Whenever the eyepiece is changed, readjust the focus by moving the drawtube slightly.

BEFORE OBSERVATION

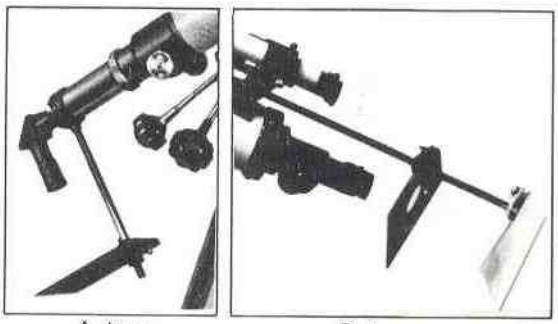
Try to focus the telescope. it is advisable to use low powered eyepiece at beginning by ordinary observation. The image of astronomical telescope will be up side down and also left and right will be reversed.

CAUTION – DO NOT FOCUS TELESCOPE ON THE SUN WITHOUT SUN FILTER ON THE EYEPIECE. DO NOT LOOK THRU THE FINDER SCOPE OR GUIDE-SCOPE TO FIND THE SUN OR PERMANENT EYE DAMAGE MAY RESULT.

OPTIONAL ACCESSORIES

SUN PROJECTION SCREEN

For prolonged solar observations, the suns image can be projected onto the sun projection screen. Assemble the sun screen as shown A or B type. Insert the diagonal prism in case of A type and the low power eyepiece with the sun filter in place.



A type B type.

CAUTION: BE SURE SUN FILTER IS IN PLACE AT THE EYELENS.

Focus the telescope on the sun by sighting through the eyepiece. When the sun is focused, remove the low power eyepiece and insert the high power eyepiece WITHOUT the suo filter in piace.

CAUTION: DO NOT LOOK THROUGH THIS EYEPIECE.

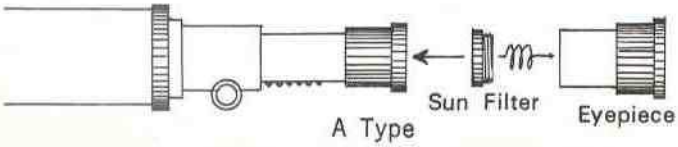
The image is thrown on the surface of the projection screen. Refocus until the image is sharp on the projection screen.

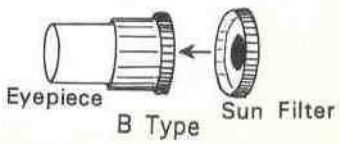
SUN FILTER

Teh sun filter is essential when viewing the sun directly with the telescope.

UNDER NO CIRCUMSTANCES SHOULD THE OBSERVER LOOK DIRECTLY AT THE SUN WITHOUT THE FILTER IN PLACE AS DIRECT OBSERVATION OF THE SUN IS DANGEROUS TO THE NAKED EYE.

A Type of sun filter is screwed into the eyepiece, and B Type of sun filter is covered on the top of eyepiece before the eyepiece is inserted into the eyepiece adapter. Sun Filter absorbs some of the heat and light of the sun so that you may observe the sun safely. Sun Filter might be cracked





because of the heat of the sun unless you turn the telescope off the sun after observing the sun for 10 minutes or so. If this care is neglected, Sun Filter might be cracked and the eye might be hurt.

" DO NOT LOOK THE SUN WITHOUT SUN FILTER "

MOON FILTER

Because there is a great deal of reflected giare when the full moon is observed, the addition of the moon filter will remove this glare and make it possible to sharpen surface details. At other times, this filter is unnecessary and a sharper image can be obtained without it. The moon filter is screwed into the eyepiece in the same way that the sunfilter is added.

FINDER SCOPE

Finder is a guide telescope for catching an object easily before using the main telescope. When the object is seen at the center of this finder, the object must be seen at the center of the main telescope. In order to adjust the position of the finder properly, you may look at a chimney or something about 500m distant at the center of the main telescope and adjust the finder by turning its set screws so that the object may come.

DIAGONAL MIRROR

It is advisable that Diagonal Mirror may be used at the time of astronomical observation for long periods of time. The image of left and right will be inverted.

2X BARLOW LENS

This lens will automatically double the power of any telescope. The lens is inserted in the eyepiece adapter of the telescope and the eyepiece is then inserted on the far side of the lens. The relative brightness of the telescope is also reduced.

The 2X Barlow Lesn is a valuable accessory to your telescope, but because of the extreme magnification power, it should be used only when necessary. Experience will teach that moderate power are best for most observations.

TERRESTRIAL EYEPIECE (T-18mm)

For terrestrial viewing (things on the earth), insert the T-18mm eyepiece into the draw tube. And focus until objects become clear. The image will now appear upright and corrected from left to right.

SPECIAL NOTES

Your telescope is a precision optical instrument, that is like any other optical instruments it should be kept away from dust and moisture which are two biggest enemies to the optics.

When lenses get dirty, blow off the dust particles before cleaning the lenses, then clean the lens gently with moistened lens tissue. The lenses should not be taken apart, and the surface of the lenses should be kept free of finger smudges. To clean the surface of the lenses, we recommend wiping with a Kleenex-type tissue and blowing the lens off with an ear-type syringe.

After the observation, keep the telescope in a dry dust free place. With this care, your telescope will become your good friend in your lifetime.

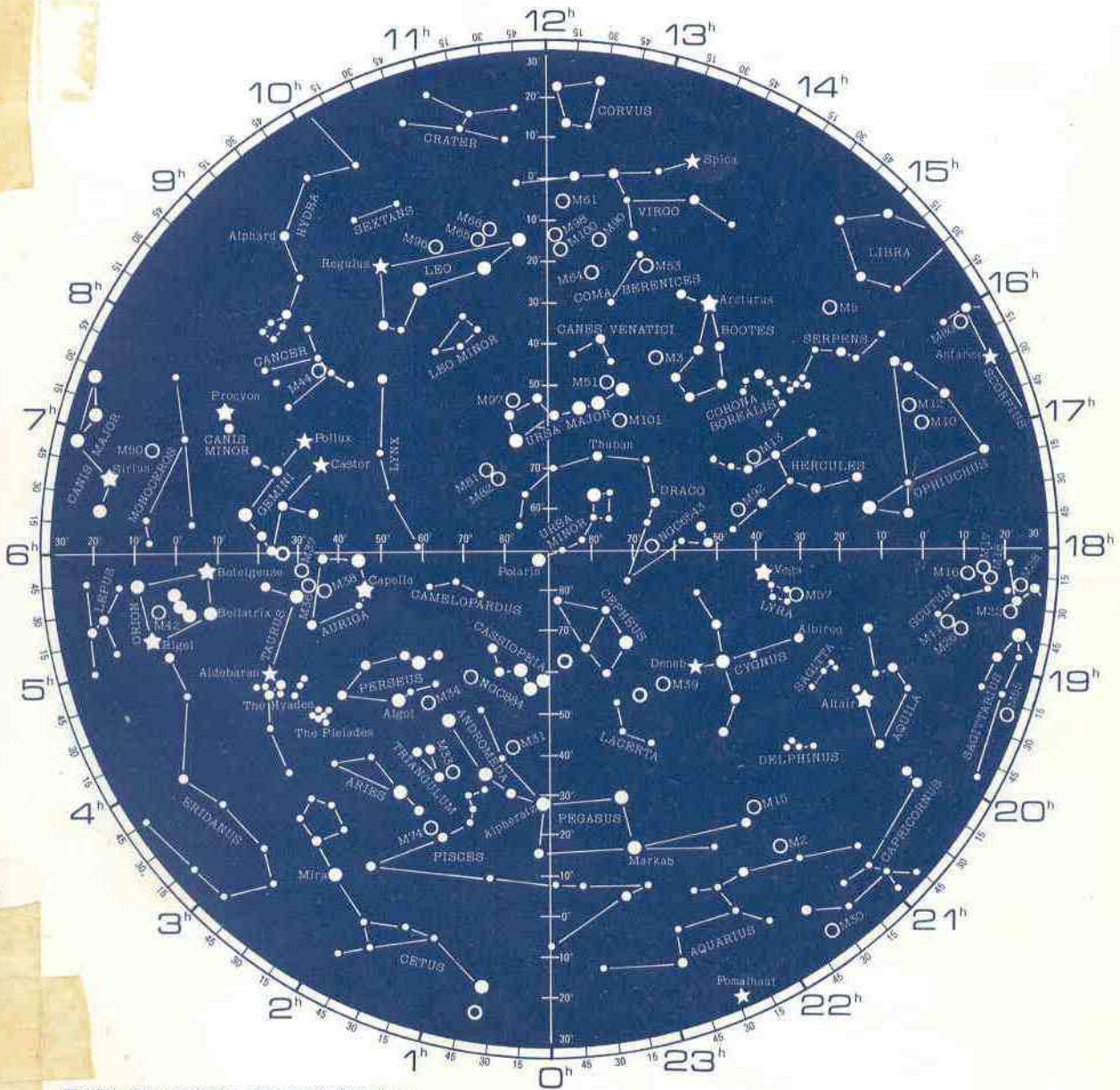
CARE OF THE TELESCOPE

The novice of astronomer always thinks of power. The power of a telescope is one of the important factor, but it is not most important quality of the telescope. It is needless to say that the resolving power is more important than the magnification for the telescope. The magnification is theoretically unlimited, but the practical number of magnifications should not exceed about 60 power per inch of diameter of the objective lens for ideal viewing. When this ratio is exceeded, the quality of the image produced diminishes rapidly.

Accordingly, for best results in most observations, it is better to employ the lesser powers. This gives the observer the benefit of a larger field of view, a brighter and crisper image, and sharper detail. The high powers should be used only when it is necessary to look at a small area. Experience will teach that moderate power are best for most observations.

STAR CHART

This star chart illustrates the most conspicuous located in the Northern Celestial and is arranged specifically for latitude 40 degree north. Hold this map toward the north and turn it around until the current month is at the center.



EXPLANATION OF SYMBOLS

★ STARS BRIGHTER THAN 1st MAGNITUDE

★ 1st MAGNITUDE STARS

● 2nd MAGNITUDE STARS

• 3rd MAGNITUDE STARS

· 4th MAGNITUDE STARS

O NEBULAE

O STAR CLUSTERS

M MESSTER NUMBER

PRINTED IN JAPAN