TELESCOPE BASICS

MANUAL

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TELESCOPE BASICS

EYEPIECES & MAGNIFICATION

Your telescope comes with eyepieces of different focal lengths. Eyepieces allow you to view a magnified image in your telescope. The smaller the focal length of the eyepiece, the more magnification you will get with your telescope. High power eyepieces make things appear much closer, but have a narrower field of view, meaning you see a smaller amount of sky. This can make it more difficult to locate small objects, such as planets. When first trying to locate an object, use your longest focal length eyepiece (lowest power). This will give the widest field of view possible and will make it much easier to find your target. Once you have the target centered in your eyepiece, you can switch to a high power eyepiece to get a closer view. When you are ready to find another target, switch back to your low power eyepiece.

25 mm eyepiece   10 mm eyepiece

The amount of magnification an eyepiece provides with a given telescope can be calculated using this formula:

$$\text{MAGNIFICATION} = \frac{\text{FOCAL LENGTH OF THE TELESCOPE}}{\text{FOCAL LENGTH OF THE EYEPIECE}}$$

This formula can be used with any new eyepieces you decide to purchase for your telescope.

NOTES ON THE USE OF HIGH MAGNIFICATION

Sometimes local weather conditions can affect how much magnification you can use at any given time. If you look at bright stars with the naked eye and they appear to be twinkling or rapidly changing color, the atmosphere is not stable enough for sharp views under high magnification. On nights like this, the edge of the Moon or planets may appear as if you are viewing them through running water. If this occurs, switch eyepieces to slightly lower magnification and see if the image stabilizes. If it doesn't, increase the focal length (lowering the power) further until the view becomes steady. The stability of images can change from night to night and even hour by hour. For more on the effects on seeing conditions, please see the Tips for Astronomical Observing section (page 8).

FOCUSING

In order to see the sharpest image possible, you need to focus the eyepiece. Focus will depend on many factors, such as distance to your target and the eyepiece you are using, but can also depend on the person looking through the telescope.

While looking through the eyepiece, slowly turn the focusing knobs located below the eyepiece at the base of the focuser. You should see the image go from blurry to sharp. If you keep turning the knob and pass the focus point, the image will become blurry again. Simply turn the knobs back the other way until you find the sharpest image.

What may look focused to you may not be in focus for someone else. If you are sharing an image of the Moon or a planet with someone, don't forget to remind them to refocus the eyepiece so they can see the sharp details that you did.

VIEWING WITH EYEGLASSES

When you look through an eyepiece, your eye must be a specific distance from the top lens of the eyepiece in order to see the full image circle the eyepiece provides. If you are too far away, you will only see the center of the view and the edges are cut off. If you are using an eyepiece with a long eye relief distance, you may be able to view through the eyepiece with your glasses on. To test this, look through the eyepiece with your glasses on, then take them off and look again. If you can see the same field if view with your glasses on, you can view while wearing them. If you notice that the view without your glasses on offers a far larger field of view, you should not wear your glasses when using this eyepiece.

You can always view without your glasses on, but you will need to adjust the focus knobs to compensate for your vision. If you are observing with other people, they may need to readjust the focus when they view through the telescope.

If you suffer from severe astigmatism, the telescope may not focus as sharply as when you are wearing your glasses.

If you are considering the purchase of additional eyepieces for your telescope, you should look at eyepiece designs that offer at least 18 mm of eye relief to give yourself a better chance of observing with your glasses on.

IMAGE ORIENTATION

If you have an astronomical refracting telescope and you were to insert an eyepiece directly into the telescope's focuser, you would see an image that was upside down and mirror reversed. Because observing straight through the telescope can be difficult to use when looking directly overhead, astronomers use a mirror diagonal to make the eyepiece more accessible. The mirror in the diagonal also flips the image so that it is correctly oriented up and down. However, it will still appear backwards left to right. This is perfectly normal.

Optical systems such as spotting scopes and binoculars give a correctly oriented image, but they were designed for terrestrial observing. They use complex sets of prisms that flip the image so that it appears correctly oriented. Astronomers avoid using additional glass elements in the light path such as mirrors or prisms because each time light strikes an optical surface some of the light is absorbed by the glass and is lost to the observer's eye. The prisms in spotting scopes and binoculars will reflect the light path 4 to 5 times before sending it to the eyepiece, losing a little bit more light each time. When looking at faint targets, such as galaxies or nebulae, the astronomer wants his or her eye to capture every photon of light possible to see the faintest detail. This is not a problem for daytime terrestrial telescopes where daylight is plentiful–and nobody wants to see wildlife upside-down or backwards! If you really want to use your scope for terrestrial viewing with a fully corrected image, there are optional prism assemblies available, but check with the manufacturer as not all refractors can reach focus with all erecting prisms.

Newtonian reflector telescopes were also designed for astronomical use and images of terrestrial objects will appear upside-down. Because the design uses two mirrors, the images you see are correct left to right and up and down, but the views are rotated, depending on the angle of the focuser and the ground as well as how you hold your head to the eyepiece. Using a diagonal like the refractor would actually cause more problems by mirror reversing the image and not really correcting the image at all. Unfortunately for Newtonian telescopes, there is no easy way to correct this.

Astronomers don't mind an upside-down view since there is really no up or down in space. It is all a matter of perspective. Because the Earth we live on is roughly shaped like a sphere, a person in Australia looking at the Moon with the naked eye would see it upside-down compared to a person simultaneously observing it from Alaska. They are looking at the same object, but from different perspectives.

Image orientation as seen with the unaided eye & using erecting devices on refractors & Newtonians.

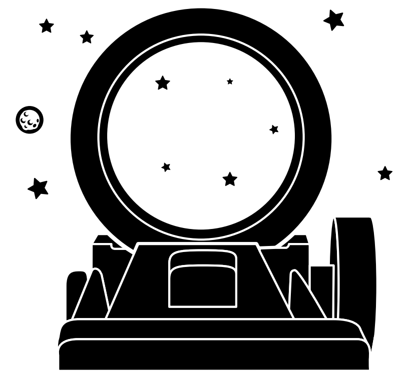
Reversed from left to right, as viewed using a Star Diagonal on a refractor.

Inverted image, normal with Newtonians & as viewed with eyepiece directly in a refractor.

WHAT TO EXPECT WITH YOUR NEW TELESCOPE

APPARENT MOTION OF THE SKY

Unlike fixed targets on the ground, astronomical targets move across the sky. This is caused by Earth's rotation. When you observe a celestial target in your telescope, such as the Moon or planets, it will appear to slowly drift across the field of view of your eyepiece. The higher the magnification of your eyepiece, the faster the object will appear to drift. In order to keep the object centered in the field of view, you will have to nudge the mount in altitude and azimuth. To maximize your viewing time between nudges, watch the target drift across the field of view to see what direction it is heading. Try to position the scope just ahead of it, and then watch as the target drifts into the field of view from one side and exits the other.



MAGNIFICATION AND STARS

Your telescope will magnify objects and make them appear much closer than they are. As you increase magnification on the Moon, you will see details within the craters and mountain ranges. Planets such as Jupiter and Saturn will increase from a small point of light to a noticeable disk. Stars, on the other hand, will not increase in size, no matter how powerful an eyepiece you use. Why? Stars are too far away to be resolved as a sphere. If you could bring them 250 times closer by using a very high power eyepiece, stars would still only appear as a pinpoint of light, even through large professional telescopes. However, your telescope will show you the separation between double stars. Some deep-sky objects, such as the Orion Nebula, may look like stars to the naked eye, but under magnification, it will appears as a large “fuzzy” cloud through your telescope.

RELATIVE BRIGHTNESS OF OBJECTS

Celestial objects can vary dramatically in brightness. Astronomers use a scale called “apparent magnitude” to compare the relative brightness of these objects. The star Vega, in the constellation Lyra, serves as the baseline to which all other objects are compared. Vega is considered to have a brightness of magnitude 0. Though it may seem counterintuitive, as the brightness of a star or other celestial object increases, its number on the magnitude scale decreases. According to this scale, the Sun has the greatest brightness with a magnitude of -27, while the faintest stars the unaided human eye can detect under perfect dark conditions are magnitude 6.

The limit to what the unaided human eye can see varies depending on the size of your iris (the opening of your eye). The average adult human iris can only open about 7 mm when fully dark-adapted. Astronomers use telescopes with larger apertures to collect more light and focus it to a point that can enter the 7 mm iris of your eye, allowing you to not only see more detail, but fainter detail than you would otherwise. The larger the aperture of your telescope, the more detail you can see.

The first targets you should consider finding are the bright ones. As you gain familiarity with your telescope, you can start looking for fainter objects.

Here are some suggestions on where to start in order of brightness:

The Moon

Your telescope will reveal excellent detail on the Moon. Try observing the "terminator," the line of darkness on the edge of the Moon's disk. Observing along the terminator provides the best detail of craters and other surface features. Try your higher-power eyepiece to see the Moon up close.

The Planets

Saturn and Jupiter are the best planets to observe. You can see the rings around Saturn and the moons of Jupiter through your telescope. During certain times, you can even see the shadow of Jupiter's moons on Jupiter's surface. Under good sky conditions you can observe cloud bands on Jupiter.
Venus will not show much surface detail, but you can see the phases from a thin crescent to a thick gibbous as it moves around the Sun.

Mars will appear as a ruddy colored disk and, at times, may show a polar cap. The best time to view Mars is when it is closest to Earth (called opposition). Due to the orbits of Earth and Mars, this only happens once every two years, so make sure not to miss it!

Stars

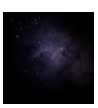
Stars many not look any larger in your telescope, but they can still be interesting targets. Try observing single stars to compare and contrast their varying colors. In the winter skies, the easily recognizable constellation of Orion showcases two of the more extreme examples. Betelgeuse in Orion's shoulder is very reddish, while Rigel in Orion's foot is very bluish-white.

Double Stars

Double stars, which are close pairs of stars, some of which are gravitationally bound, can also offer some beautiful contrast. The star Albireo, which marks the nose of the swan in the constellation Cygnus, is a beautiful example of a bright golden-yellow star with a dimmer blue companion star.

Star Clusters

Star clusters, or loose groups of stars are also beautiful targets. The Pleiades star cluster in the constellation Taurus is a very close group of hot blue stars, visible to the naked eye on a dark night. Your telescope will reveal beautiful gas clouds surrounding the cluster in a low power eyepiece. The Double Cluster in the constellation Perseus, also visible with your low power eyepiece, is composed of two tight knit groups of stars. Another type of cluster is a globular cluster. Its stars are so tightly packed together that it is difficult to differentiate individual stars. The best example of this is the Great Hercules cluster in the constellation Hercules. This type of cluster looks best in very dark skies away from city lights.



Nebulae

Nebulae can be very faint and difficult to see, but there are a few examples that are rewarding even from suburban skies. The Great Orion Nebula in the constellation Orion is very easy to see. It appears as a collection of stars that represent the "sword" hanging from Orion's belt. In a low power eyepiece, you will see four stars in a trapezoid pattern surrounded by a greenish-blue haze. Inside this vast nebula, new stars are being formed. Under dark skies, this nebula can take up a sizable portion of the eyepiece.

Galaxies

Galaxies are notoriously difficult to track down, because they are extended objects with very low surface brightness. This makes them hard to see unless you are under extremely dark skies, but there is one galaxy that is fairly easy to find. The Great Andromeda Galaxy in the constellation Andromeda can just barely be seen with the unaided eye in dark skies. It can even be seen with 10x50 binoculars from the suburbs. In the eyepiece, you will see an elongated whitish glow, which may stretch across most of the eyepiece field.

SEEING COLOR

When you look at pictures of nebulae in scientific publications you will see lot of red, blue and yellow nebulosity. The view through the eyepiece does not look like this. Keep in mind that these published astroimages are created over long exposure periods. Photographic film and image sensors can collect and store light over time, and are far more sensitive to the many different colors present. Your eye, on the other hand, sees on an instant-by-instant basis and is most sensitive to the green part of the spectrum. This is why most nebulae appear greenish-grey in the eyepiece.

TIPS FOR ASTRONOMICAL OBSERVING

SELECTING AN OBSERVING SITE

If you are going to be observing deep-sky objects, such as galaxies and nebulae, you should consider traveling to a dark sky site away from city lights and upwind of any major source of air pollution, with a relatively unobstructed view of the horizon. Always choose as high an elevation as possible to lower the effects of atmospheric instability and ensure that you are above any ground fog.

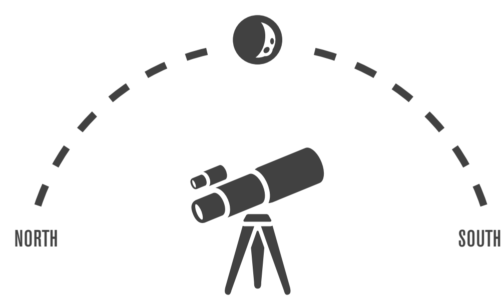
While it can be desirable to take your telescope to a dark sky site, it is not always necessary. If you plan to view the planets, the Moon or even some of the brighter deep-sky objects, your own backyard is a perfect location. Set up the scope out of the direct path of streetlights or house lights to help protect your night vision. Try to avoid observing anything that lies within 5 to 10 degrees over the roof of a building. Roofs absorb heat during the day and radiate this heat out at night, causing a layer of turbulent air directly over the building that can degrade your image.

Observing through a window is not recommended because the window glass will distort images considerably. And an open window can be even worse, because warmer indoor air will escape out the window, causing turbulence. Astronomy is an outdoor activity.

CHOOSING THE BEST TIME TO OBSERVE

Try not to view immediately after sunset. After the Sun goes down, the Earth is still cooling, causing air turbulence. As the night goes on, not only will seeing improve, but air pollution and ground lights will often diminish. Some of the best observing time is often in the early morning hours before dawn.

Objects are best observed as they cross the meridian, the imaginary line that runs from north to south through a point directly over your head. This is the point at which objects reach their highest points in the sky and your telescope is looking through the least amount of atmosphere possible. Objects that are rising or setting near the horizon will suffer more atmospheric turbulence since you are looking through a much longer column of air. It is not always necessary to have cloud-free skies if you are looking at planets or the Moon. Often broken cloud conditions provide excellent seeing.



COOLING THE TELESCOPE

Allowing your telescope to acclimate to outdoor temperatures minimizes heat wave distortion inside the telescope tube. Give your telescope at least 10 minutes to cool down to outside air temperature, or longer if there is a big difference between the temperature of the telescope and the outside air.

ADAPTING YOUR EYES

If you are planning to observe deep sky objects, allow your eyes to fully adapt to the dark by avoiding exposure to white light sources such as flashlights, car headlights, and streetlights. It will take your pupils about 30 minutes to expand to their maximum diameter and build up the levels of optical pigments necessary to see the faint light from a distant target. If you need light to help set up your telescope, try using a red LED flashlight at a low brightness setting and avoid looking straight at the light source.

When observing, it is important to observe with both eyes open. This avoids eye fatigue at the eyepiece. If you find this too distracting, cover the unused eye with your hand or an eye patch. The center of your eye works well in bright daylight, but is the least sensitive part of the eye when trying to see subtle detail at low light levels. When looking in the eyepiece for a faint target, don't look directly at it. Instead look toward the edge of the field of view and the object will appear brighter.

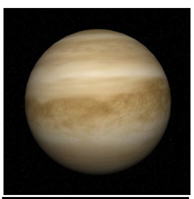
PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING THE PLANETS**

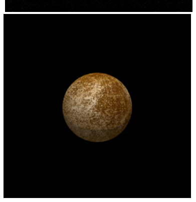
There are five planets that are visible to the naked eye - Mercury, Venus, Mars, Jupiter and Saturn. To the unaided eye, these planets will look similar to stars. Uranus and Neptune are too faint to see with the unaided eye, but in a telescope they will appears as slightly bloated stars. Planets change positions against the background stars on a daily basis. Don't fear, though. With a little preparation and some knowledge of what to expect, you will be able to pick them out of the sky and find them in your telescope quite easily.

First, go online and use your favorite search engine to look for "visible planets." You will find a large number of web sites that offer printable planet finder charts that are good for the current month. These charts will usually specify a time and date to use them. For example, the map may show the sky at 11:00 PM for the beginning of the month, but may also be used at 10:00 for mid-month dates and 9:00PM at the end of the month. Hold the chart over your head and rotate the chart so that the north part of the map is facing north. Match up the brighter stars and constellations shown on the chart with the stars you can actually see and then look for the planets pointed out on the chart.

Other web sites may have more accurate interactive star charts. To use these, you need to enter the date, time, and your location and the site will generate a map of the stars with plotted positions of the planets. You can print the charts and take them outside with you when you observe. As with the charts described above, you would need to hold them over your head with north on the map pointing north to use them correctly.

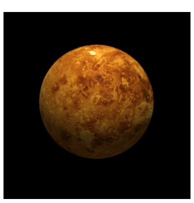
Even though planets move against the stars from day to day, they stay in a very limited strip of sky, called the ecliptic. Planets are usually the brightest objects along the ecliptic.





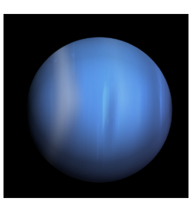
Observing Mercury and Venus

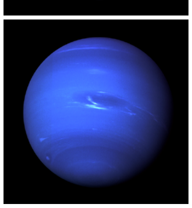
Because Mercury and Venus orbit so close to the Sun, they never appear to stray too far from it in the sky. As a result, these planets are usually seen in the early dawn before sunrise or twilight after sunset. You only have a short time to view these planets before they set below the horizon or the glare from the rising sun swallows them up. Mercury is always so low to the horizon that magnified images will rarely offer more detail than a small ruddy disk. Venus will rise higher and is, at times, brighter than anything in the sky other than the Sun and Moon. It is so bright that many people mistake it for an airplane. Due to the high amount of cloud cover on Venus, you will never see any surface detail, but you can see the planet go through phases like the Moon, from a small crescent to a large gibbous as it circles the Sun. If you view these planets, it is best to do this when the Sun is fully below the horizon to avoid accidentally viewing the Sun through your telescope, which can cause irreversible damage to your eye.



Observing Mars

Mars orbits farther from the Sun than Earth does. During opposition, when the Earth and the planet are closest to each other, the planet will rise at sunset and be visible in the sky all night. Due to the relative speeds of Earth and Mars, Mars only comes into opposition once every two years. Around the time of Mars' opposition, the planet is at its largest and can start to show some subtle detail such as a polar cap and some shading of surface features. At opposition, it is possible to see one of the polar caps with a small telescope.

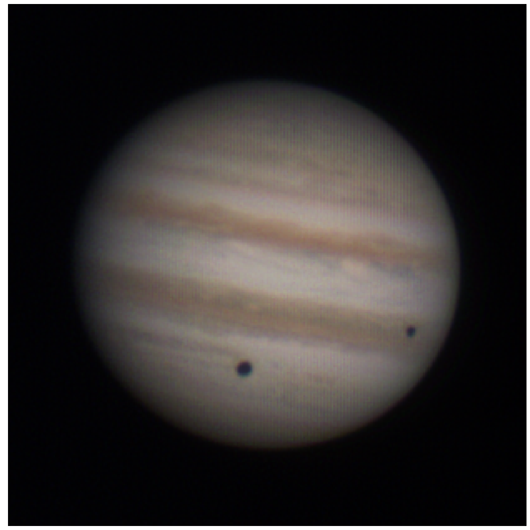




Observing Uranus and Neptune

Uranus and Neptune are too far away to show any detail. Even under high power, they appear slightly larger than a star, but what is really noticeable about these planets in an eyepiece is their stunning greenish-blue color.

OBSERVING JUPITER



Jupiter and Saturn are, without a doubt, the most beautiful planets to view in any telescope. We'll look at them in more detail. Jupiter is the largest planet in the solar system. It has a very thick atmosphere of gas, but has no discernible solid surface. When we view Jupiter, we can only see the outer layers of its atmosphere, but there are still many wonders to see.

When you look at Jupiter through a telescope, the first thing you'll notice is its size. Jupiter is definitely not a star. Even at low magnification, the planet resolves into a pale tan disk. At higher magnifications you will see that the disk is not perfectly round; it's a little wider in diameter at the equator than measured through the poles. This is caused by Jupiter's high rotational speed, taking just under 10 hours to complete one revolution.

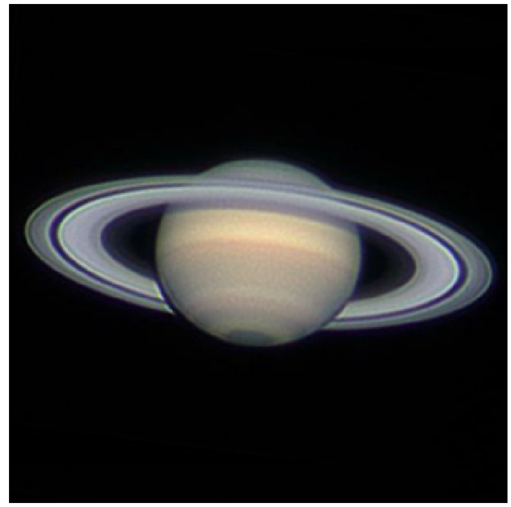
Look carefully at the disk and you will see darker cloud bands crossing the face of the planet, like stripes on a billiard ball. The clouds appear as stripes due to different wind conditions at different latitudes, which can exceed 200 miles per hour (320 km/h). The turbulent areas sandwiched between these layers can create massive storms that force up layers of compounds from the lower atmosphere, which react with sunlight to create the red and brown hues seen in the clouds. Since these interactions are constantly changing, Jupiter will look a bit different each time you view it.

One of the most famous features of Jupiter is the Great Red Spot, a giant storm that is larger than three planet Earths in diameter and has been going strong since it was first recorded in 1831. Similar to the equatorial cloud bands, the color of the Great Red Spot can change. For the past few years, the spot has changed from red to a pale salmon pink, making it a little more difficult for small telescopes to see.

Another fascinating reason to keep your eye on Jupiter is its moons. Jupiter has 67 moons at last count. Unfortunately, only a handful of them can be seen from Earth. When you view Jupiter through the eyepiece, you will see four small star-like objects that appear to the right or left of the planet, forming a rough line with Jupiter's equator. These are the Galilean moons—Io, Europa, Ganymede and Callisto—first discovered by Galileo Galilei in 1610. They were the first celestial objects found to orbit a body other than the Earth or the Sun. Three of these moons are larger than Earth's moon and Ganymede is even larger than the planet Mercury.

These moons orbit Jupiter very quickly. Io takes less than two days to complete one orbit of Jupiter, while Callisto, with the longest orbit of the Galilean moons takes almost 17 days. This is much faster than Earth's moon, which takes close to 28 days to complete one orbit. This means the moons will look different every time you view the planet. Sometimes you will not be able to see all four moons at the same time as one or more of them may be hidden in the planets shadow or behind the planet itself. One of the more special treats you might see is a transit of one of the moons or one of the moon shadows crossing the face of the planet. You can check online for programs that allow you to predict the lunar transits, shadow transits and eclipses of Jupiter's moons so you can plan observing sessions around these special events.

OBSERVING SATURN



Saturn is the second largest planet and a gas giant similar to Jupiter. The planet appears yellowish due to its ammonia-rich upper atmosphere. Like Jupiter, Saturn has very high equatorial winds that can reach 1100 miles per hour (1800 km/h), but it lacks the contrasting dark color bands seen on Jupiter. Sometimes large storms can appear as white spots but can dissipate quickly.

The main thing you notice when you look at Saturn for the first time is its incredible ring system. These rings are primarily made of small particles of ice with traces of rocky material. They extend 75,000 miles (120,700 km) above the planet's equator, but have an average thickness of less than half a mile (0.8 km).

The rings were first glimpsed by Galileo Galilei in 1610 in his early refracting telescope, but he was not able to see them clearly enough to determine what they were. He originally thought Saturn was three bodies orbiting closely but not touching. It was not until 1655, that Christiaan Huygens first described their true nature as a disk surrounding the planet. In 1675, Giovanni Domenico Cassini discovered that this disk around Saturn was actually a series of smaller rings separated by gaps. The largest dark gap in the rings between the bright A and B rings is called the Cassini Division in his honor. This gap spans 3000 miles (4800 km) and is visible in telescopes if the seeing conditions and ring angle are favorable.

Roughly every 15 years, observers on Earth see Saturn's rings completely vanish from sight. Saturn's orbit around the Sun is slightly inclined to Earth's orbit. This means that twice during Saturn's 29.5 year orbit of the Sun, Saturn's rings are viewed edge-on from Earth. Because the rings are so thin, they cannot be seen and all that is visible is the planet itself. The last occurrence of this was September 4, 2009. In the years since, the angle between the Earth and Saturn has opened up, allowing us to see a more of the rings. In 2016, the rings will once again be at their widest before slowly starting to close, disappearing again in 2025.

Saturn has 62 confirmed moons, but only a few are visible in small telescopes. Titan, discovered by Christian Huygens in 1655, is the second largest moon in the solar system. Like Jupiter's Ganymede, it is also larger than the planet Mercury. The next largest moons, Rhea and Iapetus are less than 70% of the size of Titan and may be visible in telescopes as small star-like points of light.

HOW TO FIND DEEP-SKY OBJECTS

You have now viewed the Moon and planets. It's time to take the next step on your journey to the cosmos and look for your first objects beyond our Solar System.

DEEP-SKY OBSERVING EQUIPMENT

Red Flashlight

This is an essential tool for deep-sky astronomy for reading finder charts or star atlases. In order to see the faint light coming from distant objects like nebulae or galaxies, your eyes must be fully dark adapted with your irises fully open to let the most light from your telescope into them. White light from a standard flashlight will cause your irises to close down and it can take up to 30 minutes for your eyes to return to full dark adaptation. Red lights do not have the same effect. We recommend any red LED flashlight that has adjustable brightness output, because even red light, if excessively bright, can affect your night vision. We recommend the Celestron PowerTank Glow 5000. It's the perfect brightness and can also charge your personal electronics.

Planisphere

A planisphere is a special circular star map that will show you the rough placement of constellations over your head, so you can navigate your way across the sky. Unlike charts you can print online, planispheres work at any time of year, not just the date or month you printed it for. The planisphere consists of two round disks joined at the center. The bottom disk has a map of the constellations while the top disk has a window cut into it out showing a portion of the sky map. By turning the inner and outer disks to match your specific date and time, the map will display only those constellations visible to you at that time. This is handy for finding rough locations of bright stars and constellations. Planispheres are available at most bookstores. Be sure to pick one that is designed for your location, as planispheres correspond to geographical latitudes in the Northern or Southern Hemispheres.

Star Atlas

Star atlases are the roadmaps of the sky. Once you have located a constellation with your planisphere, the star atlas will show you a detailed, close-up view of that region of sky showing the stars and deep-sky objects that reside in it. These are available at many telescope retailers or bookstores.

Apps and Programs

There are many smartphone and tablet applications that take the place of planispheres and star maps, including the SkyPortal app from Celestron. These will give digital representations of the night sky on your device, allowing you to go from a wide view to a zoomed-in view with a touch of the screen. Try searching your device's app store to see what's available.

There are also some great astronomical sky simulation programs available for your computer with very detailed on-screen star maps, tools to help you plan an observing session, and printable star maps customized for your time and location. If you recently purchased a Celestron telescope, you should have received a code for a free download of Celestron's Starry Night astronomy software.

STARHOPPING

The easiest way to find your way around the sky is using a technique called “starhopping.” To get started, measure the field of view of your finderscope.

Measuring the Field of View of Your Finderscope.

1. Look in the sky and locate a constellation with bright stars. You can use your planisphere to help identify it. Now find the map in your star atlas that shows this constellation.
2. Center your finderscope on any bright star that you can recognize on the star map.
3. Hold your head 12 inches behind the reflective window of your StarPointer finderscope and move the telescope so that the bright star is at the edge of the field if view of the window (it does not matter which direction you pick).
4. Without moving the telescope, look through the finderscope window and locate another star near the opposite edge of the field of view.
5. Locate this second star on the chart. Measure the distance between these two stars on the chart using a ruler. This distance is represents one finderscope field of view on your atlas. You can now use this measurement to locate celestial objects.

Locating Celestial Objects

1. Once you have identified an object you want to find, locate it on your star atlas. Use the map to determine what constellation it lies in and what bright stars are near it.
2. Now use your planisphere to locate the constellation in the sky and try to locate the bright stars you found on the star chart near your target. Move your telescope so that the bright star is centered on red dot of your StarPointer finderscope.
3. Using the scale you just created, find out how many fields of view of the finderscope you need to move and in what direction to go from the bright star to your target. Looking through the finderscope, move the telescope the same number of fields of view and in the same direction as indicated by the map. When you are done, your telescope should be very close to your target.
4. Look through the lowest power eyepiece you have and see if you can see it. If you don’t see it, you can start a systematic search of the local area. Look through your eyepiece and slowly move the scope back and forth, up and down. Try not to move more than one field of view of the eyepiece at a time so you don’t miss seeing it. Be sure to move slowly and take your time. If you still can’t find it, don’t worry. Just go back to your bright star and try it again. With a little patience and some practice, you will be able to locate these objects without much trouble.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING DOUBLE STARS**

Double Stars

Double stars, or pairs of stars that appear close together in the sky, are rewarding objects to observe. In some cases, these stars are so close together that they appear to the unaided eye as single stars, but under the magnification of a telescope, they resolve into a very closely separated pair. Some of these pairs show a very striking difference in color between the stars. The great thing about double stars is that they are not as affected by light pollution as other deep-sky objects are.

Some double stars will require higher magnifications to cleanly separate the two component stars. Astronomers use special eyepieces with measuring reticles to measure the separation and angle of the two stars. Repeated measurements of the stars' angles over long periods of time show how fast the stars orbit each other.

Star atlases, astronomy programs, and mobile apps will identify double stars using a different symbol than single stars. Use the starhopping method described above to locate these gems of the sky. Here are a few examples of easy to find double stars to get you started.

Observing Albireo

Albireo is one of the most beautiful examples of a double star and, lucky for us, it is very easy to locate. Albireo appears to the naked eye as a single star in the easily recognizable constellation Cygnus the Swan and marks the nose of the celestial bird. What is striking about this double star is the color, a bright yellow star paired with a dimmer blue companion star. This pair has a separation of about 1/1000th of a degree.

Observing Mizar

Mizar is a very easy double star to find, as it is located in the Big Dipper, in the constellation Ursa Major. It is the second star from the end of the handle. Arabic texts suggest that this double star was used as a test of eyesight, as some people can see both component stars without optical aid. They are separated by 1/5th of a degree. The fainter companion star has its own name, Alcor.

Observing Gamma Leonis (Algieba)

Gamma Leonis, also known by the Arabic name Algieba. It is located in the easily recognizable constellation of Leo the Lion, in an asterism called the Sickle of Leo. This group of stars, representing the lion's mane, resembles a backwards question mark with Regulus, the brightest star in the constellation Leo, at the very bottom. Algieba is a very close double star. The most striking feature of this pair is the color differences, with one star being an orange-red and the other being a greenish-yellow. In 2009, astronomers discovered that the primary star in this system, Gamma Leonis 1, has a planetary companion that is almost 9 times more massive than Jupiter. Further data suggests that there may be a second planet orbiting this star with a mass twice that of Jupiter, but further investigation is needed.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING STAR CLUSTERS**

Star Clusters

Star clusters are groups of stars that are packed into a small area. Clusters that have loosely distributed stars are called open clusters and can contain hundreds of stars. Clusters that are very tightly packed in a small area are called globular clusters, which can contain hundreds of thousands of stars. For open clusters, you should use low power eyepieces to better frame the cluster. For globular clusters, try low power first, and then boost up to a higher power to try to resolve as many of the stars as possible.

Observing the Pleiades

The Pleiades is an open cluster located in the constellation Taurus the Bull. It is a large open cluster of very bright blue stars and is easily seen with the naked eye. It is only about 400 light years from Earth. This cluster is large and best appreciated with low power eyepieces. This cluster has been recognized and recorded by many cultures all over the world. In Japan, this cluster is known as Subaru and was adopted as the name and logo of the automobile manufacturer.

Observing the Double Cluster

The Double Cluster in the constellation Perseus is a beautiful telescopic object, or more accurately, objects, since there are two distinct open clusters in the same field if view. To the unaided eye, this cluster appears as a fuzzy patch in Perseus, but a small telescope or binoculars resolves this into to open clusters approximately one degree apart. Each cluster contains a few hundred stars. Be sure to use low power eyepieces with this object to get both clusters together, and then switch to higher magnification to inspect each cluster in more detail.

Observing the Hercules Globular Cluster

The Hercules Globular Cluster is the most beautiful example of a globular cluster in the northern skies. It is conveniently located between two bright stars in the constellation Hercules and is just barely visible to the unaided eye on a dark night as a fuzzy star. It can be seen easily in binoculars, but looks better through a telescope using low to moderate magnification. This cluster contains hundreds of thousands of densely packed stars.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING NEBULAE**

Nebulae
Nebulae are large clouds of ionized gas or dust that lie in interstellar space.

They can be classified into three basic categories:

Emission Nebula - These nebulae are rich in HII (pronounced H2), or ionized hydrogen. The ionized hydrogen glows as a result of high-energy photons emitted from a nearby massive star. Emission nebulae usually contain star forming regions where the gas clouds coalesce and new stars are born. They can also be found at the other end of a star's life cycle, when a massive dying star sheds it outer layer into space. The gas expands into a spherical cloud and is ionized by the star's exposed core. This special type of emission nebula is called a **planetary nebula**.

Reflection Nebula - These nebulae are often rich in HII, but do not give off light of their own. Instead, these nebulae reflect the light from nearby stars that are not massive enough to excite the ionized gas.

Dark Nebula - These nebulae are clouds of dust and HII, but are not illuminated by close stars. They are only seen because they block the light from stars behind them, creating dark areas in an otherwise bright star field.
Many of these nebulae are very large objects and under dark skies, you may trace them over a sizable percentage of the view in a low power eyepiece. Planetary nebulae are usually small in diameter and will look better using moderate to high power.

Observing the Orion Nebula

The Orion Nebula is a "stellar nursery," a large diffuse HII region where new stars are forming. It is extremely easy to locate, visible to the naked eye as a small fuzzy patch in the constellation of Orion. The nebula appears as a jewel in the sword that hangs from three stars of Orion's belt. This is one deep-sky object that has very high surface brightness and even looks good from suburban skies, though dark skies will show significantly more detail. Use low magnification for this object as it is big and you'll want to see it against the dark backdrop of the surrounding sky. The nebula appears as a faint greenish glow in the eyepiece, with a brighter center portion with a dark gulf on one side. The glow of this emission nebula comes from the star cluster at the center. The four brightest stars in the cluster are known as the Trapezium for the trapezoidal shape they form. Astronomers know that more stars are being formed in this nebula, but they are shrouded from view by the gas and dust.

Observing the Lagoon Nebula
The Lagoon Nebula is another excellent example of an HII star-forming region. Under dark skies, this nebula is just visible to the naked eye in the constellation Sagittarius. In a low power eyepiece, the greenish-gray nebula appears as a star cluster surrounded by an oval shaped glow with a brighter core. This nebula contains a number of Bok globules, dark clouds of gas condensing into new stars.

Observing the Ring Nebula
The Ring Nebula is a planetary nebula that was created when a red giant star, near the end of its life, blew off its outer shell, leaving behind an exposed core that would evolve to a white dwarf star. It is located in the constellation Lyra, between the two naked eye stars representing the base of the lyre and only about 6 degrees from Vega, the second brightest star in the northern hemisphere. The nebula looks like a small blue smoke-ring in lower magnifications. Using magnifications of 100x or more will show a bright edge with a noticeably darker center.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING GALAXIES**

Galaxies

A galaxy is an immense system of millions or billions of stars along with gas and dust that are gravitationally bound together. Most galaxies range from 3,000 to 300,000 light years in diameter and are separated from each other by vast distances of millions of light years. If you have gone outside on a dark night and seen the Milky Way stretching across the sky, you are seeing the disk of our galaxy—from the inside. Distant galaxies are very faint can only be seen under dark skies with fully dark-adapted eyes. Most will appear as elongated smudges of light in the eyepiece. To see hints of the delicate spiral structure in most galaxies, you need a very large telescope with a diameter of at least 11 inches (280 mm).

Observing the Andromeda Galaxy

The Andromeda Galaxy is spiral galaxy that lies approximately 2.5 million light years from Earth in the constellation Andromeda. It contains over a trillion stars, double the amount in our own Milky Way galaxy. It is the only distant galaxy visible to the naked eye on a dark, moonless night. The Andromeda Galaxy is currently on a collision course with our Milky Way Galaxy, traveling towards us at close to 200 miles per second (315 km/sec). The collision is expected to occur in about 4 billion years, when both galaxies will possibly merge to form one giant elliptical galaxy.

Because the Andromeda Galaxy is such a large object, it's best viewed using a low power eyepiece. In long exposure images of this galaxy, the galaxy can take up 3 degrees of sky, or 6 times the diameter of the full moon. However, in most telescopes, only the bright central core is visible. When starhopping to this object, you will find the constellation Andromeda does not have many bright stars. An excellent starting point is with the 5 bright stars of the nearby constellation of Cassiopeia, which is shaped like the letter W (or M depending on the season or time of night).

STORAGE, TRANSPORTING AND MAINTENANCE

Your Celestron telescope is a precision instrument and should be kept indoors when not in use. For day-to-day observing, the scope can be left fully set up. Just make sure the covers are in place to prevent dust from entering the telescope tube.

Always carry the telescope from the mount and not from the telescope tube. Most beginner telescopes are the perfect size to take with you on your next camping trip. We recommend packing the scope in its original box to prevent it from being damaged on the way.

Clean the outside of the telescope and mount with a damp cloth. We do not recommend using any solvents or cleaners on the outside of the scope. Never attempt clean the telescope's mirrors. Unlike a bathroom mirror where the reflective surface is behind the glass, the mirrors on your telescopes have a metallic coating on the top surface of the glass. Wiping the mirror can lead to scratches in the surface coating that will affect your image quality far more than a thin layer of dust.

The finderscope lens and eyepieces can be cleaned with optical lens tissues available at most photography supply stores. Eyepieces should be handled with care to avoid touching optical surfaces.

ADDITIONAL RESOURCES

How to Contact Celestron

For assistance with this product, please visit Celestron's online technical support center at:
https://www.celestron.com/pages/technical-support.

Here, you may search through a comprehensive database of frequently asked questions or submit a request for assistance.

Written correspondence may be sent to:

Celestron • 2835 Columbia Street • Torrance, CA 90503

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celestron.com/pages/technical-support
2835 Columbia Street • Torrance, CA 90503 U.S.A.

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