Acadiana Sky

TELESCOPE OBSERVING HINTS

1. What can I see in a small telescope?

The sun: You can see sunspots and other phenomena, but always observe safety precautions (see #13, below).

The moon: Craters are spectacular, particularly near the moon's sunrise or sunset line (called the terminator).

The planets: Venus will show moon-like phases, and so might Mercury, depending on the size and quality of your telescope. Mars will be a disappointment. Four of Jupiter's moons will be easy, and some cloud markings might be seen. Saturn will look just like its picture; and Uranus and Neptune, like green stars. Pluto requires a fairly large diameter instrument and very dark skies far from city lights.

The stars: Many double and variable stars are interesting and within range of a small telescope. The Milky Way is interesting with large numbers of stars and star groups visible at low power.

Deep sky objects: The showpieces! Look for open and globular clusters, galaxies, and different types of nebulae. A small telescope often shows these objects as hazy, indistinct patches of light. Don't expect objects to look like they do in books—remember that photos in books are usually time exposures with big telescopes!

2. What can I see in binoculars?

Many of the things that are visible in small telescopes are also visible in binoculars. In fact, some are more spectacular when viewed in the binoculars! Since binoculars give you low magnification but a wide field of view, they often give you a better feel for how an object fits in among its apparent neighbors. Generally speaking, binoculars are more for pleasure viewing than for serious astronomical study. Start with either 7x35 or 7x50 binoculars, and mount them on a camera tripod if you can.

The sun: Not recommended for binocular viewing!

The moon: Binoculars show lunar phases and close approaches of the moon to bright planets and stars quite well. They're also good for lunar eclipses.

The planets: Use binoculars to watch the motions of the planets relative to background stars, and to see the motions of Jupiter's moons.

The stars: The best stars for binoculars are the same as for small telescopes — wide double stars, variables, and especially the Milky Way.

Deep sky objects: Binoculars won't show much detail in these objects, but will still give some spectacular views. Sometimes binoculars will show more than one of these objects in the same view. In the summer, search through and around Sagittarius to find many picturesque nebulae and clusters. Most Messier objects are within grasp of a good pair of binoculars, but many are a real challenge.

3. <u>How much magnification?</u>

Magnification, resolving power, and light-gathering power are the three most important functions of a telescope. Magnification is just how much larger a telescope makes an object appear, compared to the unaided eye. For instance, two power (2x) means twice as big and twenty power (20x) means twenty times as big. As a general rule, you'll find that you can't use a magnification greater than 50 to 60 times the diameter of your telescope in inches (or twice the diameter of your telescope in millimeters). For instance, you can use up to 150x with a 3" telescope, or up to 120x with a 2.4" telescope; on the other hand, even a large telescope can seldom use more than 500x. If you use too much power, the image will get worse instead of better. You'll find that you can usually only use maximum power on the very best of nights; magnifications more than half to two-thirds the maximum typically result in poor images. Generally, you may prefer to use your low powers for normal viewing, saving your high powers for those good, steady nights when the stars aren't twinkling much.

Figuring out each eyepiece's magnification is easy. First, find your telescope’s focal length. This may be printed on the telescope near the eyepiece holder (or in the manual) as something like F= 900 mm. If it isn't there, find the f-number (f/10, f/15, or whatever); multiply the number after the slash by the telescope diameter to get the focal length (if the answer is in inches, multiply it by 25.4 to convert to millimeters). Next, look at your eyepiece—it will probably have some measurement printed on it (1", 1/2", 20 mm, 12.5

mm, and 4 mm are common), and this is the eyepiece focal length. To get the magnification, just divide the telescope focal length by the eyepiece focal length. Be sure that both measurements are in the same units (inches or millimeters).

$$Magnification = \frac{F}{f} = \frac{focal\ length\ of\ the\ telescope}{focal\ length\ of\ the\ eyepiece}$$

4. <u>What is resolving power?</u>

Resolving power is a measure of how close two stars can be, and still be seen as separate stars; it's also important in determining how small a detail can be seen on the moon or a planet. It's measured in seconds of arc (one second of arc is the angle covered by a US quarter seen at a distance of 3 miles). The smaller the resolving power, the better; the bigger the telescope's diameter, the smaller the resolving power. It's important to know your telescope's resolving power or you'll waste time trying to see things that are too small for your instrument. It’s easy to find your telescope’s resolving power.

$$Resolving\ Power = \frac{4.56\ seconds\ of\ arc}{telescope\ diameter\ in\ inches}$$

or

$$Resolving\ Power = \frac{115\ seconds\ of\ arc}{telescope\ diameter\ in\ millimeters}$$

As an example, here’s the resolving power of a 3” telescope.

$$Resolving\ Power = \frac{4.56\ seconds\ of\ arc}{telescope\ diameter\ in\ inches} = \frac{4.56''}{3} = 1.5''$$

If the diameter of the same size telescope were listed as 76 mm, the resolving power would not change.

$$Resolving\ Power = \frac{115\ seconds\ of\ arc}{telescope\ diameter\ in\ millimeters} = \frac{115''}{76} = 1.5''$$

A 3" (76 millimeter) telescope wouldn't split double stars that are closer together than that, and a better working value would be twice the resolving power (3 seconds of arc in this case).

By a happy coincidence, the resolving power quickly tells you the size in miles of the smallest thing you can see on the moon. Just calculate the resolving power and then double it (so with a 3" telescope with a resolving power of 1.5 seconds of arc, the smallest thing visible on the moon would be about 3 miles across). Again, a better working value would be twice that, or 6 miles. The working values are needed because the atmosphere isn't crystal clear, and because telescope optics aren't always perfect. Smaller detail can be seen if it is in the form of lines rather than craters.

5. <u>What is light-gathering power?</u>

This is a measurement of how much light your telescope objective picks up. It's usually expressed as a comparison or ratio between two telescopes, and depends on the area of each scope's objective (the lens or mirror that first picks up the light and makes it focus). Calculating your telescope's light-gathering power as compared to another telescope's is pretty simple—just divide the squares of the diameters.

$$Light\ Gathering\ Power = \frac{diameter_{big\ scope}\ X\ diameter_{big\ scope}}{diameter_{small\ scope}\ X\ diameter_{small\ scope}}$$

As an example, let's see how much more light-gathering power a 6" telescope has than a 3" telescope.

$$Light\ Gathering\ Power = \frac{6\ X\ 6}{3\ X\ 3} = \frac{36}{9} = 4$$

So, a 6" telescope has twice the diameter of a 3" telescope, but 4 times the light-gathering power.

Try using this method to compare the light-gathering power of your telescope to that of the human eye. The approximate diameter of a dark-adapted eye is one-third inch. (8.5 mm).

6. <u>How do I see through my telescope?</u>

There's more to it than just taking a peek! Observing is an art, and the more you do it the better you'll get. Try some land viewing first. The image will probably be upside-down, backwards, or both, but don't let that bother you. The point is that land viewing gives you practice in focusing, moving the telescope, setting up, and other basic functions. Do your first astronomical observing at twilight when you can see the moon and maybe some planets, but still have enough light to see what you're doing. Once you have some practice, observe later at night. Be sure your eyes are dark-adapted (this takes at least 10 to 15 minutes—stay away from bright lights after going outside).

Keep your eye centered on the eyepiece, close to it without actually touching. Try to keep your eye close to the "exit pupil" (see below). Try to learn to keep both eyes open while observing—it's much less tiring than squinting (if necessary, simply cover the eye you're not using with your hand). If you wear glasses, see if you can get a clean focus on stars without them; if you can, you'll see a wider view in the eyepiece, and keep the eyepiece from scratching your glasses. If you must wear glasses, be careful not to scratch them by bumping them on the eyepiece. In either case, don't strain to see as you focus; adjust the focus to avoid eyestrain.

On some objects (such as galaxies, nebulae, and clusters), look off to one side and around the object. This is called "averted vision", and shows detail that might otherwise be missed (this happens because the outer portion of the retina is most sensitive to faint light).

Don't use more magnification than the night permits—when the image no longer focuses nicely, you've used too much. Always use your lowest magnification when trying to locate an object because that will give the brightest image, the sharpest focus, and the widest field of view.

7. What is an exit pupil?

The exit pupil is the image of the objective formed by the telescope eyepiece. To find it, focus your telescope on a daylight scene (NOT the sun!) and hold a piece of tracing paper or wax paper behind the eyepiece. Move the paper around until the image of the scene is as small as possible, and you have found the exit pupil position. When observing, try to keep your eye close to that area, or else you'll have difficulty seeing the complete image. The distance from the physical eyepiece to the exit pupil is called eye relief. Each eyepiece is different, but you will get used to finding the right spot quickly and easily. However, high power, short-eye-relief eyepieces can be difficult to use for beginners and children.

8. What are "seeing " and "transparency"?

These are measures of sky quality. Good seeing means that the air is steady and the stars twinkle slightly or not at all. Poor seeing means the stars are twinkling violently. Good transparency means that very faint stars are visible, whereas poor transparency means that they are not. It's possible to have one of these qualities mediocre or poor and the other very good.

9. What is light pollution?

Light pollution is unwanted light from artificial sources falling on your telescope or directed up into the sky. It can come from your own lights or those of a neighbor, but the greatest amount comes from street lighting and advertising lights. The skies over most American cities are now so bright that most stars cannot be seen; in some cases, objects barely visible to the unaided eye in the countryside are barely visible in good-sized telescopes in the city! To reduce light pollution, turn out your own lights and politely ask your neighbors to turn out any they have that shine on your observing site (they may be happy to do that if you show them some things through your telescope and they notice how annoying their own lights are!). Some telescopes and eyepieces accept light pollution filters (sometimes called nebula filters) that reduce the effect of light pollution, but the only way to avoid most city lighting is to leave the city. Getting a little out of town will help a lot, but seeing the faintest things your telescope can show means getting far from town. Be sure you get permission to be on whatever land you end up using—don't trespass!

10. What is magnitude?

Magnitude is just a system of measuring the brightness of stars. The brighter the star, the smaller its magnitude number. A star of magnitude 1 is brighter than a star of magnitude 2. The brightest night-time star is Sirius at magnitude -1.46, the dimmest stars visible without optical aid are about magnitude 6.5, and the dimmest stars visible to the largest telescopes are about magnitude 30. Each magnitude is about 2 ½ times brighter than the next dimmer one (for instance, a star of magnitude 4 is about 2 ½ times brighter than a star of magnitude 5).

11. What is limiting magnitude?

Limiting magnitude, sometimes simply called LM, is a measure of how faint an object can be seen under given conditions. On a beautifully clear night far from lights, the limiting magnitude for the unaided eye might be 6.5 or so. Under the same conditions in a small town, the limiting magnitude might be only 5.0 or 5.5 because the sky has been brightened by lights. In a major city, the limiting magnitude could well be 3 or 4 (or even worse). That site far from lights that has a limiting magnitude of 6.5 on a clear night might have a limiting magnitude of only 4.5 or 5 on hazy nights. Experience will tell you when a night is good enough for observing various kinds of objects.

The limiting magnitude of a telescope or a pair of binoculars will increase with the instrument's diameter; that is, the bigger the diameter, the fainter an object can be seen. The limiting magnitude of a 60 mm (2.4") telescope is about 11.6, while a 150 mm (6") telescope has a limiting magnitude of about 13.6 (making thousands of extra objects visible). The limiting magnitude of an instrument will vary according to such things as the skill of the observer, the transparency of the air, the amount of light pollution, and the quality of the instrument. Objects invisible in town may be easy in the countryside.

12. What condition are bad for observing?

Avoid nights of poor seeing (when stars twinkle violently) and poor transparency (when faint stars appear to be missing). The light of the full moon drowns out faint objects (although on those nights, the moon itself and the brighter planets and double stars may make fine viewing). Don't observe over heated rooftops or you'll see stars bouncing in an effect like that of heat waves coming off a car's hood in the summer. Don't stick your telescope out an open window and expect to see anything, because the difference in outside and inside temperatures will stir the air and ruin the image. On any night, avoid observing objects near the horizon where the seeing is worst.

13. What conditions are good for observing?

Observe the sun (Safely! See How can I observe the sun safely with a telescope?) during mid-morning when possible—the sun is then well above the horizon, but the air is normally still. Observe the moon and bright planets in twilight, when possible, in order to reduce their glare. Most deep sky objects such as nebulae and galaxies require a dark sky with good transparency and little light pollution. When observing after twilight, get out away from the city whenever possible to reduce “light pollution", the light from city lights. If you can't do that, at least get away from nearby lights, or into an area of shadow.

14. What is "dark adaptation", and why is it important?

Most people have probably had the experience of turning out the lights in a room and finding that seeing in the dark becomes better after several minutes. Dark adaptation is just the process of "getting used to the dark." Under light polluted city skies, an observer becomes reasonably well dark adapted after 10 to 15 minutes; under very dark countryside skies, the process takes 20 to 30 minutes, with perhaps some improvement for up to an hour. To see the sky well with the unaided eye, binoculars, or a telescope, don't forget to allow enough time for this process to happen. Once it happens, avoid any lights except moderately dim red lights.

15. What kind of lights do I need at the telescope?

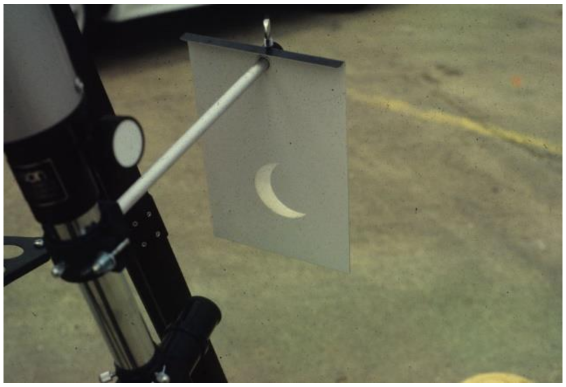
Since the whole point is to be in as dark an area as possible, you'll need very few. Read star maps, atlases, notes, setting circles, and nearly everything else with a flashlight that gives off a rich red light (that's red, not pink!). The light need be only bright enough to allow comfortable reading; the dimmer it can be, the better it will preserve your night vision. Red LED flashlights using AA or AAA batteries are nearly ideal. You may find it handy for the light to be small enough to hold in your mouth, leaving your hands free for reading material or moving the telescope (it's also possible to buy red lights attached to a headband). Some people prefer to put the light on a stand on a small, portable table. Another handy trick is to tie a string or shoelace through the hole found on the bottom of many flashlights, then hang the flashlight around your neck (that way, you'll always know where it is). If you can't get a red flashlight bulb, try coloring the bulb with paint, fingernail polish, or glass stain; if you don't want to make the flashlight red permanently, use a red filter, plastic, or even a red spray can lid taped to the front. A bright, white light flashlight is handy during set up to check the site for ant hills, poison ivy, or other dangers, and it's also handy at the end of an observing session to check the site for dropped eyepieces, trash, or other items that may be forgotten. Using a white light while observing, however, will ruin your night vision.

16. <u>What about star charts and observing guides?</u>

There are a number of interesting ones. *Turn Left at Orion*, by G. Consolmagno and D. M. Davis is a good guide for beginners, as is *NightWatch*, by Terence Dickinson. *Norton's 2000.0 Star Atlas and Reference Handbook*, edited by I. Ridpath, is particularly good when the initial confusion about your telescope is over and you're ready to get more serious (it's currently out of print, but not yet difficult to find). There are an increasing number of astronomy apps (and "planetarium software), too, but be sure to get a version with a night vision mode that makes the screen red. Some are free.

17. <u>How can I observe the sun safely with a telescope?</u>

There are a couple of safe ways. But first — ***never*** look directly through a telescope or binoculars at the sun. Serious eye damage or even blindness *will* result. Do you have a solar filter with your telescope that screws into the eyepiece? ***Throw it away!*** They go into the telescope light path near the place where the energy is most concentrated, and have a nasty habit of cracking when you least expect it. However, a quality solar filter over the telescope's objective end (the end you point at the sky) can be safe, if it has no way to fall off (expect to pay at least $50 to $100, depending on the size and type of your telescope, and much more than that for filters for larger telescopes). The cheapest, safest



way to observe the sun is called solar projection. Put in a low power eyepiece, aim at the sun by watching the telescope's shadow, and completely cover the finder scope's front lens. Now simply hold a piece of white cardboard behind the eyepiece as shown in the picture, and focus—you'll have a solar image several inches across on which you can find sunspots, faculae, and granulation. The advantage of solar viewing is that the image is easy to see and form, and is visible on any clear day. The disadvantage is that there is too much light, and it has to be reduced to safe and usable levels. Remember to be very, very careful in order to protect your telescope and your eyes. If your telescope is more than about three or four inches in diameter, use an aperture stop to cut it down to that size. If you don't do this, you can easily melt a lens (I know -- I did it in college!) Speaking of lenses, try to use a Ramsden-type lens for solar projection; other kinds contain optical cement that may expand with the sun's heat and shatter the glass in the eyepiece. If you don't have one or don't want one, try using your least expensive eyepiece for no more than about ten minutes at a time. Be careful—results will vary from telescope to telescope! To save your eyes, use either solar projection or a good quality objective filter, and remember that it's better to be too careful than not to be careful enough. ***Safety first!***

18. <u>What can I do to stay interested once the newness has worn off?</u>

One idea is to get with a local astronomical society. You can find them by watching for advertising about their observing parties, or you can check with the local planetarium or Chamber of Commerce. Many of them have Facebook pages, or a presence on other social media. The Astronomical League (https://www.astroleague.org/) has links to clubs all over the United States. You can keep track of monthly events by reading "Astronomy" or "Sky and Telescope" magazines (if you don't want to subscribe, these magazines can usually be found at libraries). Speaking of libraries, don't overlook them as good sources of astronomy books. You'll have to choose carefully to get one at whatever level of understanding you have, and to avoid the poorer books that invariably slip in, but there is much good information to be had. Try to get recent books, particularly if you're looking for a text rather than an observing guide. Don't forget planetariums, either. No matter where you go around the country there will probably be one somewhere nearby. The programs will give you more information about astronomy, it may be possible to buy books and other astronomy-related items, and the staff can often help you if you have observing problems.

After observing a while, you may find yourself particularly attracted to a specialized part of observing, such as occultations, the solar system, binaries, or variables. Believe it or not, there are worldwide groups who specialize in these things. Examples are the American Association of Variable Star Observers (AAVSO), and the International Occultation Timing Association (IOTA). You might also enjoy a systematic search for comets, especially if you find one and get to hang your name on it…but be ready for the search to take years—at least!