

# Astronomer's Observing Log



"The pleasures of amateur astronomy are deeply personal. The feeling of being alone in the universe on a starlit night, cruising on wings of polished glass, flitting in seconds from a point millions of kilometers away to one millions of parsecs distant ... is euphoric."

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# Deep-Sky Observing

## Introduction

For centuries astronomers were mainly preoccupied with Earth, the planet on which they lived and the solar system. Consequently, only nineteen objects outside the solar system were known. Today, hundreds of thousands of objects have been discovered that lie beyond our solar system and are known collectively as deep-sky objects.

These include huge clouds of gas and dust called nebulas, which can be divided further into emission nebulas, reflection nebulas, and planetary nebulas. The first two are associated with stellar birth, while the latter are expanding shells expelled from dying stars. Star clusters form a second grouping of deep-sky objects. Open star clusters are made up of anywhere from a dozen to several hundred young, chiefly blue-white stars. Most of these stellar swarms lie within the spiral arms of our own galaxy, the Milky Way. Globular star clusters, made up of some of the oldest stars known, surround the hub of our pinwheel-shaped Milky Way. Each contains between 100,000 and a million constituents. Finally, beyond our Milky Way, are myriad island universes called galaxies. Some are spiral shaped like our own, while others are elliptical or irregular in appearance. These distant worlds are the objects of study for the deep-sky observer.

Observing the deep sky requires time, patience and a willingness to learn. Thousands of objects are within reach of a modest telescope. Through practice and experience, anyone can master the art of deep-sky observing. There is a wealth of deep-sky objects awaiting your scrutiny.

“The amateur astronomer has access at all times to the original objects of his study; the masterpieces of the heavens belong to him as much as to the great observatories of the world. And there is no privilege like that of being allowed to stand in the presence of the original.”

- Robert Burnham, Jr. – Burnham’s Celestial Handbook



# Equipment

## Optics

In addition to the naked eye, observing the night sky with binoculars has many advantages. Binoculars are compact, lightweight, and ready instantly, either for a casual glance at the night sky or for an in-depth study of the universe. Astronomy on the go! Finding objects via star-hopping can be done easily by first using binoculars before moving to the telescope.



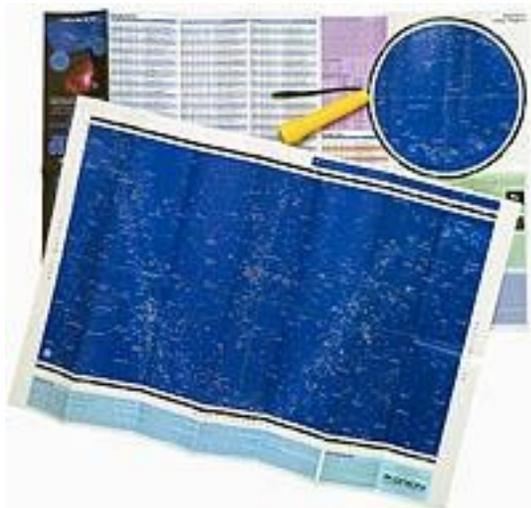
## Star Atlases

All navigators, no matter how experienced, rely on maps to guide them. To find celestial objects with binoculars or a telescope, you need the right resources. A good star atlas is an invaluable tool. The fainter a chart's limiting magnitude, the more stars it shows, but the more familiar you must be with the sky to navigate among them. If you're using binoculars, you'll want an atlas that shows stars to magnitude 6 or 8. If you have a telescope, then SkyAtlas 2000.0 is essential. A more detailed atlas with a limiting magnitude of 9 or 10 allows you to locate fainter objects. Serious astronomers should consider the Millennium Star Atlas; it shows more than a million stars to magnitude 11.

These and others are available from Sky Publishing Corp. and Willmann-Bell, Inc.

“Fine maps bring the fascination of hunting out faint secrets in hidden sky realms.”

- Alan MacRobert – Amateur Astronomer and frequent contributor to “Sky And Telescope” Magazine



# Preparing For An Observing Session

## Dress appropriately

Comfort is everything! Jeans and a T-shirt might be fine for warm summer nights, but cold winter nights demand a wiser choice. A sensible jacket, with several pockets, can be worn over a sweater and shirt to keep the upper part of your body warm with long johns for your legs. Wear two pairs of woolly socks and make sure your shoes or boots provide insulation, so that your feet don't leak heat to the ground. Most important of all, protect your extremities. Your nose, ears and fingers will lose heat more quickly. A balaclava and scarf will serve admirably, and a pair of warm, non-bulky mittens will keep your fingers agile and comfortable.



## Snack food

Food is an essential part of any observing kit. A favorite is coffee and tea. Something hot to drink after you have just found that elusive galaxy adds to the reward. A sandwich, or some chocolate adds a little extra boost during your vigil at the eyepiece.

## Bug repellent

Mosquitoes are the bane of the deep-sky observer. Nothing is more ominous than the high-pitched whine of these blood-sucking pests. Bug spray or lotion easily solves the problem.

## Flashlights

Deep-sky observing is done in the dark. You will need some light to read the star charts, make notes and find your mug of hot coffee. Astronomers traditionally use a dim red flashlight because red light has less effect on night vision. Simply place sufficient layers of dark red cellophane on the front of the lens, thereby cutting down and filtering the light.

Much better than the traditional flashlight and red filter, however, is a red LED (light-emitting diode) flashlight. Its red is purer and deeper, so the division between rod and cone vision is more sharply drawn. Another trick for preserving dark adaptation is to observe with one eye and read charts with the other. Keep the observing eye closed or covered with an eye patch when not in use.

## Observing notebook

Don't forget your notebook. Even if you use a tape recorder, one often needs to make notes. And, of course, you should be sketching.

### **Accessory table**

You'll need somewhere to put all the stuff you've packed in. You can carry all your maps, books, notebooks and "stuff" in several plastic crates. These stack securely one on the other, making a handy table. Sometimes, an extra chair is also handy as a makeshift table.

### **Comfortable chair**

Observers often overlook the fact that they will be spending a considerable amount of time sitting at the eyepiece. Make sure your chair is comfortable and supports you in the right places. Bear in mind that the eyepiece will not be at a constant height throughout the night; some form of adjustable chair may be needed. If you don't sit at the eyepiece, periods of standing are regularly interrupted by moments of sitting down, making notes, planning, and just enjoying the night sky.

### **Protect star maps from dew**

The best way to protect your star atlas from dew is to keep it indoors. Make photocopies of each map you will use at the eyepiece. You might want to scribble notes in the margin of the maps. The loose-leaf pages fit well in plastic sleeves. Also, a stack of maps, held in place on a clipboard, is well protected if a plastic sheet tops off the pile.

### **Zap the dew on your optics**

Having your eyepieces dew up can unexpectedly end your observing session. A blast of hot air for a few seconds will defog the dampest eyepieces, mirrors or lenses.



## Planning Your Observing Session

Searching for deep-sky objects is a great way to hone your observational skills. It is a good idea to do some homework before you go out to observe.

Find out when the moon rises and sets, and work out how much time you will have to observe without the moon interfering. Draw up a list of objects to view. When selecting an object, make sure it will be high enough above the horizon so that the murky atmosphere doesn't interfere.

If you are going to draw up your own lists, begin by looking for some of the brighter "showpiece" objects, and then slowly graduate to more difficult targets as your observational skills develop. Apart from choosing your own objects, you can work according to an established observing project.

Your first project might be the Messier Catalog of deep-sky objects. You can then move on to the Caldwell Catalog or double stars. Some of these objects can be quite challenging in small telescopes. Another project involves the study of the 400 Herschel objects. Sir John Herschel was the first person to systematically survey the whole night sky with the aim of drawing up a comprehensive catalogue of deep-sky objects. The Astronomical League has several observing projects to choose from. The Saguaro Astronomy Club is also a great place to get observing lists. <http://www.saguaroastro.org/>

Software programs can help you generate observing lists and the Internet has numerous sites devoted to deep-sky observing.

AstroPlanner: <http://www.ilangainc.com/astroplanner/index.shtml>

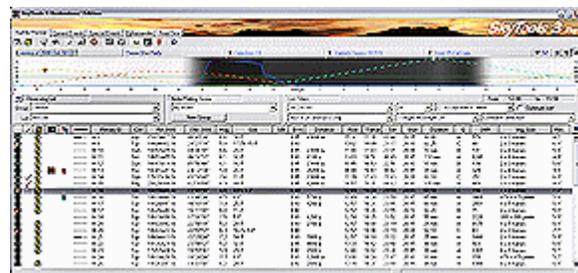
Skytools: <http://www.skyhound.com>

DeepSky Planner: <http://knightware.biz/dsp/index.php>

DeepSky Software: <http://www.deepsky2000.net/>



*Astroplanner*



*SkyTools 3*



## Observing Techniques

When you arrive at your observing site with your equipment and a list of objects to observe, you should ready the telescope for the night's work. Set up your telescope or binoculars using your red flashlight; this will give your eyes time to become dark-adapted.

Both refractors and reflectors should be allowed to reach thermal equilibrium with the surrounding air, and reflectors should be collimated properly. Take the time to identify the constellations you will be observing in and look for useful asterisms or star patterns to help you find your way. You are ready to start the search for your first object.

## Star-Hopping

One of the most basic, and valuable, observing skills is star-hopping, which is simply the following of a trail of stars from a place you know (e.g. a bright star) to a place you don't know (e.g. the galaxy you are hunting for). You can plan your star-hop at the eyepiece, but it is recommended that you plan your first star-hop in advance, while you are drawing up your evening's observing list. Find the deep-sky object in question; say a galaxy, on the star chart. Search around it for a bright star or asterism that you will be able to locate in the sky with ease. Now look for a trail of stars, which will lead you from the star to the galaxy. It is rather like playing connect-the-dots. Sometimes you might have to go a roundabout way to get to your target, or you may choose a different bright star to start from. Bear in mind that once you have found the galaxy, you can use it as the beginning of a star-hop to the next object. All amateur astronomers should learn star-hopping.

One of the first accomplished star-hoppers, Sir James South, claimed that William Herschel was able, from a cold start, to find any object in the sky in under five minutes with the 20-foot telescope.

“Getting there is half the fun, they say. This is certainly true when traveling between the stars in search of star clusters, nebulae, galaxies and such. Using a technique called star-hopping, you step your way across the heavens until you arrive at your ultimate destination. It's easy, it's fun, and it's a great way to learn the landscape of the night sky. Star hopping is like crossing a wide stream on stepping-stones. To get from point A to point B, you step, or hop, from star to star using a finder scope's (or eyepiece's) field of view as a guide. Your hops often lead to a wonderful object while taking you past a multitude of interesting sights along the way.”



- R. Garfinkle – Amateur Astronomer

“By the way, the hopping techniques you use probably will depend on your sky conditions! For instance, under extremely bright skies (or with a smaller scope), I find that “aiming” the scope with a Telrad (i.e., a “gun-sight” pointer), then doing wide-field eyepiece sweeps usually picks up any star pattern I'm trying to hop to, but under darker skies (and/or larger apertures), having a finder as well as the Telrad and Panoptic eyepiece can be very handy!”

“In the end, I guess I use a combination of finder, Telrad, and eyepiece hopping techniques with my dobsonian - and a completely different set of techniques (involving distinct north-south and east-west motions) when I'm using an equatorial mount!”

- Lew Gramer - Astronomer

Alan MacRobert offers the following star-hopping tips:

1. Double- and triple-check directions in the eyepiece. Always think in terms of celestial north, south, east and west, never up, down, left or right. If you have an equatorial mount, polar align it at least roughly. Now the mount's motions follow the four cardinal directions. Turn the finder's eyepiece to make its crosshairs line up with these directions too.
2. Remember that a map is not exactly like the sky. The magnitude-symbols used to show the stars do not accurately reflect the way we perceive stellar brightness, so don't be caught by brightness discrepancies when using a star chart.
3. Pay particular attention to star's positions. Look for patterns of at least three stars that fix the point you're after: little triangle, rectangles, kite shapes, and so forth. Triangles are the most basic units of star-hops. Pay close attention to their shapes.
4. Know your scale. Figure out how big your finder's field of view is on the chart, and also for the eyepieces you use to star-hop with.

*One tends to 'discover' a lot of interesting things while star-hopping!*

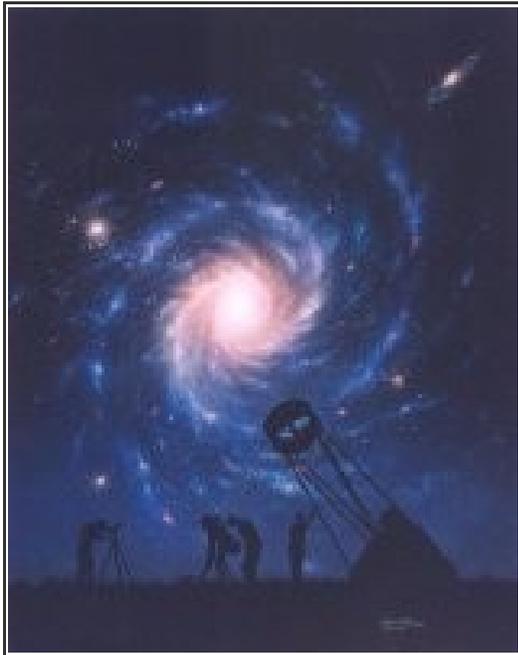
## The Art of Visual Observing

Okay, you're pretty sure you've finally got your telescope aimed at the position of the object of your desire. The crosshairs of your finder are on its exact location according to the map in front of you. Now what can you hope to see?

If it's a bright star it will be obvious and beautiful but contain no detail. A star as seen in a telescope is a tiny blaze of brilliant light looking about the same as a star does to the naked eye, only brighter.

More interesting but generally more difficult are "deep-sky objects." This term covers the vast variety of nebulae, star clusters, galaxies, and anything else beyond the solar system that appears extended: having a visible size, rather than just being a star like point. Many hundreds of these ghostly glows and subtle spatterings are within reach of a modest telescope.

Once you're precisely aimed you may see, with luck, a very dim, shapeless, glowing smudge floating among the stars. While finding it may bring a thrill of accomplishment, many novices are let down by the sight. "Is that all there is...to galaxies? It's nothing like the pictures in the books!"



You've just come up against the fact that the human eye cannot perform as well as a camera does at very low light levels. We are daytime animals that evolved in the skirts of a blazing sun; our eyes are not well designed for the dark of night and space. Your real-life view of a galaxy will never match the spectacular photos so common in books and magazines. But here lies the challenge. Many deep-sky objects do show a surprising wealth of detail when studied even with the eyes nature gave you.

A telescope serves a different function on deep-sky objects than on the Moon, planets, or scenes on Earth. In those cases, its main purpose is to magnify distant detail. With deep-sky objects, on the other hand, a telescope's main purpose is to collect a lot of light for your less-than-sensitive eye. The issue is not that the objects are too small to see without optical aid. It's that they're too dim.

Accordingly, deep-sky observing involves its own techniques. All are aimed at helping the eye to see in near-total darkness. Here are some pointers.

### Sky brightness

Light pollution is the most serious hazard the deep-sky observer faces. Deep-sky objects are extended sources of light, and their visibility is influenced by the contrast between the object and the background sky. Light pollution increases the brightness of the night sky and thus decreases the contrast between object and sky. A dark sky is even more important than a large telescope: a small instrument in the country will show faint clusters and galaxies better than a very large telescope in a city. If you have to live with light pollution, take pleasure in what can be seen.

The degree of light pollution is sometimes rated by determining the faintest star visible with the naked eye. With no light pollution, the limiting magnitude is usually assumed to be 6.5, though some people with exceptional vision can see fainter. Under such conditions, the sky is packed with stars, the Milky Way is a mass of swirling, jumbled detail and any clouds appear blacker than the sky itself. At a limiting magnitude of 5.5, clouds are brighter than the sky because they are lit from below. The Milky Way is still easily visible but far less detailed. At limiting magnitude 4.5, the Milky Way is barely detectable as a faint, nearly featureless band. City dwellers typically face a limit of 3.5.

## Dark adaptation



The eye takes time to adjust to the dark. Your eyes' pupils expand to nearly their full nighttime size within seconds of when you step out into the dark, but the most important part of dark adaptation involves chemical changes in the retina that require several minutes. After the first 15 minutes in total darkness you might think you're night vision is fully developed, but no. Tests show that your eyes gain about another two magnitudes of sensitivity -- in other words, a factor of six in how faint you can see -- during the next 15 minutes. Thereafter, dark adaptation improves very slightly for 90 minutes more. So don't expect to see faint objects at their best until a half-hour or more into an observing session.

In practice, complete darkness is unattainable. Light pollution aside, you need some light to see what you're doing. Astronomers have long used a dim red flashlight because red light has less effect on night vision. The reason is that in near-darkness you see with the "rod" cells in your retina, and these are blind to the far-red end of the spectrum. When you see red light your "cone" cells are at work; these are the receptors responsible for normal daytime color vision. (You have three types of cones -- red, green, and blue -- but only one type of rod, which is insensitive to red.) The idea is to use the red cones for reading charts and swapping eyepieces, while protecting the rods for the most delicate work at the eyepiece.

Acquiring such "dexterous vision" is one of the most valuable skills a deep-sky observer learns. Deep-sky observing has its own techniques, most of which are aimed at helping your eye see in near-total darkness. When viewing the Moon or planets, the telescope's main purpose is to magnify distant detail. Deep-sky objects, on the other hand, depend on a telescope's light-collecting ability. They are not too small to be seen without optical aid, they are too dim.

## Averted vision

While keeping the image on the same spot on the retina helps the image to build up, looking directly at it will probably cause it to disappear! This is so because the light then falls on the fovea centralis, a region packed with bright-light receptors (cone cells) but fairly poor in dim-light receptors (rod cells). The rods are concentrated around the edges of the retina. By looking slightly away from a faint object, its light falls onto the edge of the retina where it is picked up by the sensitive rod cells. This very important technique is known as averted vision. Your eye is most sensitive to a faint object when its image lies 8 to 16 degrees from the center of your vision in the direction of your nose. Almost as good a position is 6 to 12 degrees above your center of view. Never place the object to the right of center in your right eye, or left in your left eye — the image is likely to fall on the retina's blind spot and vanish altogether. Incidentally, averted vision is not the way to look for color in deep-sky objects. The rods do not respond to color, whereas the cones do. You should thus look directly at the object when examining it for color.

## Wiggling the scope

Your peripheral vision is highly sensitive to motion. Under certain conditions, wiggling the telescope makes a big, dim ghost of a galaxy or nebula pop into view by averted vision. When the wiggling stops it disappears again into the vague uncertainty of the sky background.

But under other conditions, especially involving faint objects that appear tiny, just the opposite technique may work. According to Colorado astronomer Roger Clark in his book *Visual Astronomy of the Deep Sky*, some studies indicate that the eye can actually build up an image over time almost like photographic film -- if the image is held perfectly still. In bright light the eye's integration time, or "exposure time," is only about 0.1 second. But in the dark it's a different story. A faint image may build up toward visibility for as long as six seconds if you can keep it at the same spot on your retina for that long. Doing so is quite contrary to instinct, because in bright light fixating on something tends to make it less visible with time.

Long exposure times might possibly be one reason why an experienced observer sees deep-sky objects that a beginner misses; the veteran has learned, unconsciously, when to keep the eye still. It also may help to explain why bodily comfort is so essential for seeing faint objects. Fatigue and muscle strain increase eye motion.

## Using high powers

When choosing the “best” magnification for an object, you must bear in mind that the eye has very poor resolution in dim light. In bright light, the eye can resolve detail finer than 1 arc minute, but can’t make out features smaller than 20 arc minutes when the illumination is about as dim as the dark-sky background in a telescope. This means that details in a very faint object can be seen only if they are magnified sufficiently. While a low-power eyepiece concentrates a faint extended object’s light and increases its apparent surface brightness (the illumination of a given area on the retina), it does not enlarge it sufficiently for clear resolution. Unlike a star, an extended source such as a galaxy or nebula will grow dimmer as the magnification is increased. Such an object’s surface brightness is proportional to the area of the exit pupil. Thus, an object viewed with an exit pupil 1mm in diameter has only 2 percent of the surface brightness it has with a 7mm exit pupil.



As magnification is increased, the sky background grows dimmer at the same rate that the object does, so the contrast remains the same. But with higher magnifications, delicate structure is larger and hence more visible. Faint stars are best seen at high magnification since the star’s image remains constant while the background grows dimmer, improving contrast. What all this means is that it is wise to try a wide range of powers on any object. You may be surprised by how much more you’ll see with one than another.

## Color

Deep-sky objects sometimes disappoint beginners not only by their frequent lack of obvious detail, but also by the absence of the brilliant colors recorded in photographs.



Whirlpool Galaxy – M51, C14 Photo Courtesy of Bill Burg

In order to see color, we must view something with a surface brightness great enough to stimulate the retina’s cone cells, and the list of deep-sky objects this bright is short. The great Orion Nebula M42 qualifies (some people can make out the pastel yellow or orange in parts of its brightest region), as do some small but high-surface-brightness planetary nebulae. The ability to see color in dim objects varies greatly from person to person, and surprises may occur.

Averted vision is not the way to look for color. The cones are thickest in the fovea, so stare right at your object. In this case, the lowest useful power should work best.

## Heavy breathing

When you pour all your concentration into examining a deep-sky object at the very limit of vision, does it get even harder to see after 10 or 15 seconds while the sky background brightens a little into a murky gray? Diagnosis: you’re holding your breath without realizing it.

Low oxygen kills night vision fast. An old variable-star observer’s trick is to breathe heavily for 15 seconds or so before trying for the very dimmest targets. And keep breathing steadily while you’re looking.

## **Other tips**

Night vision is impaired by alcohol, nicotine, and low blood sugar, so don't drink, smoke, or go hungry while deep-sky observing. Bring a snack. A shortage of vitamin A impairs night vision, but if you've already got enough of it, taking more won't do any good.

Prolonged exposure to bright sunlight reduces your ability to dark-adapt for a couple of days, so wear dark glasses at the beach. Make sure the label on the dark glasses says they block ultraviolet light (UVA and UVB); some cheap ones don't. Over the years ultraviolet daylight ages both your eye lens and retina, reducing sensitivity and increasing the likelihood of degenerative diseases. So if you wear eyeglasses outdoors, ask your optometrist to have an ultraviolet-filter coating applied to your glasses. This option is so cheap and easy that everyone buying glasses ought to get it regardless of any immediate medical need.

## **Taking time**

Most of all be patient. If at first you don't see anything at the correct spot, keep looking. Then look some more. You'll be surprised at how much more glimmers into view with prolonged scrutiny -- another faint little star here and there, and just possibly the object of your desire. After you glimpse your quarry once or twice, you'll glimpse it more and more often. After a few minutes you may be able to see it nearly continuously -- what astronomers call "steadily holding" an object. This where you thought at first there was nothing but blank sky.

## **Prolonged Observing**

The nature of human perception plays a significant role in deep-sky observing. In our day-to-day experience of the world we are used to seeing things easily. If something can't quite be made out, our natural reaction is to move closer. But this is impossible in astronomy. Instead, we have to get everything we can out of very distant views. This means learning new visual skills that involve active, concentrated effort. As you watch an object quiver and churn in the eyepiece, unsuspected detail will flicker into view during brief moments of stability, only to fade out for a while before being glimpsed again. The image of a difficult object builds up rather slowly. First one detail is noticed and fixed, and you think there's nothing more to be seen. But after a few minutes another detail becomes evident, then another. The skilled observer learns to remember these good moments and ignore the rest, building up a gradual, integrated picture of the object.

Related to this is the fact that the eye, like a camera, can build up an image over time. It has been found experimentally that a faint image will build up towards visibility for as long as six seconds. This may seem counter-intuitive, but bear in mind that most of your visual experiences have been in bright light; under these conditions the eye's "exposure time" is only about 1/10th of a second. Furthermore, fixating on an object in daylight tends to make it less visible. In fact, if the eye is held completely stationary, it becomes completely unable to see anything! In the dark, however, things are different.

To make use of the eye's extended viewing capacity, you will need to keep the image at the same spot on your retina; this helps explain why bodily comfort is so essential for viewing faint objects. Fatigue and muscle strain increase random eye movement. This does not, however, mean you have to stare at the object. It is the physically non-tense but mentally alert approach that succeeds on faint objects. If you use your right eye to observe, don't close your left eye tightly. This places unnecessary strain upon the eye. Keep it open and wear an eye-patch or cover your eye with a cupped hand.

You can be sure your observing skills will improve with practice. Pushing your vision to its limit is a talent that can only be learned with time. "You must not expect to see at sight," wrote the 18th-century observer William Herschel, often considered the founder of modern astronomy. "Seeing is in some respects an art which must be learned. Many a night have I been practicing to see, and it would be strange if one did not acquire a certain dexterity by such constant practice."

When you have successfully star-hopped to your target, don't expect to see right away everything it has to offer. The first look always shows less than comes out with continued inspection.

“You must not expect to see at sight . . . seeing is in some respects an art which must be learned. Many a night have I been practicing to see, and it would be strange if one did not acquire a certain dexterity by such constant practice.”

- Sir William Herschel

“As stargazers we should practice ‘the serene art of visual observing.’ We must learn to see with the mind as well as the eye. This means really examining and contemplating the varied scenes before us in the eyepiece. All deep-sky objects deserve at least 15 minutes of your time. Glancing at an object once it’s found and then rushing to another and another is like reading only the Cliff’s Notes of the world’s great novels.”

- James Mullaney – Amateur astronomer

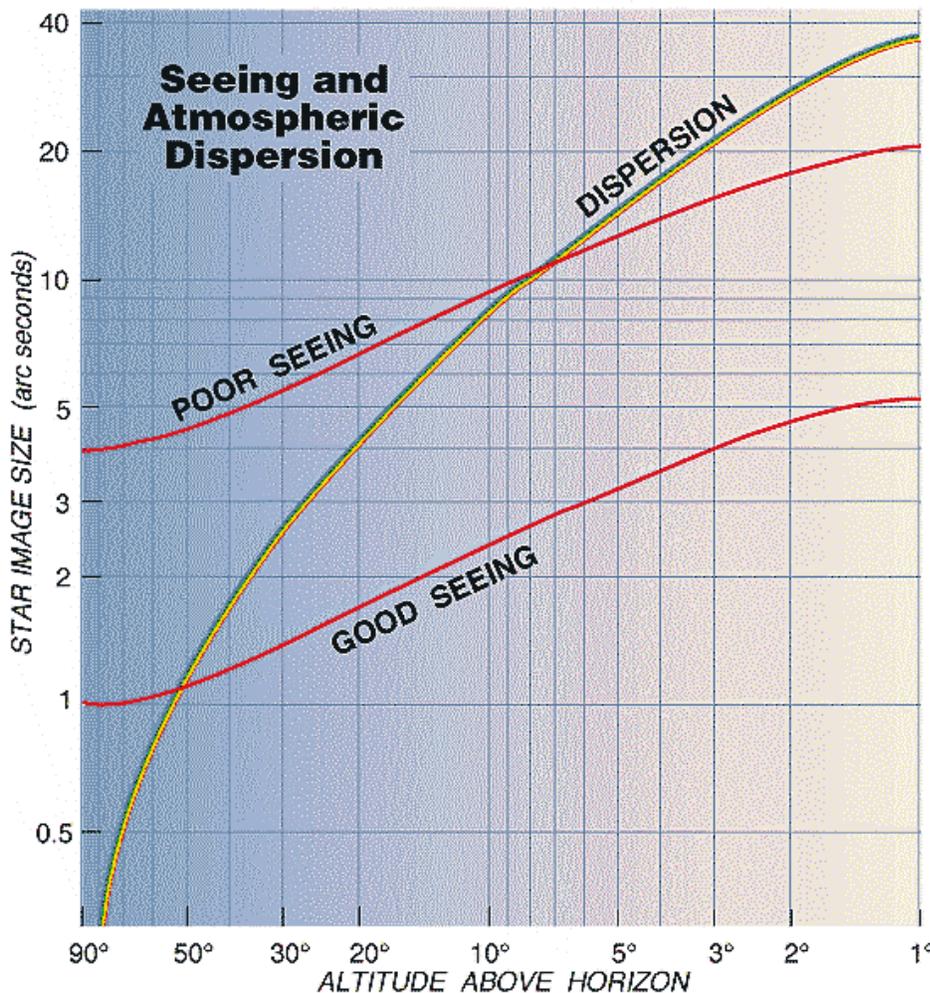


# Astronomy & Atmosphere

## *The effects of weather and the atmosphere*

“Under A Clear Sky” writes B. Schaefer, “the twinkling of stars creates an atmosphere of liveliness.” A. MacRobert says, “Viewed at high power from the bottom of our ocean of air, a star is a living thing. It jumps, quivers, and ripples tirelessly, or swells into a ball of steady fuzz.” Schaefer continues: “This rapid change in a star’s apparent brightness is termed scintillation. Even though stars subtend infinitesimal solid angles, they appear in a telescope as a finite disk with fuzzy edges. This image blurring is called ‘seeing’. When a star is viewed through a small telescope, the light appears to move around like a will-o’-the-wisp dancing around a fairy. This effect is called image movement.”

All three phenomena are closely related manifestations of turbulence in the atmosphere. Robert Hooke first advanced the correct idea in 1665 when he suggested the existence of “small, moving regions of atmosphere having different refracting powers which act like lenses.” The refractive index of the air varies slightly from point-to-point due to small changes in temperature and density caused by turbulent motions of the winds and heating from the ground. So the path of a beam of light passing through the atmosphere will be bent and kinked from the random scatterings imposed by the weak refractive prisms of air. An observer on the ground will be able to see light from a point source by looking in many directions at once. This spreading of the light into a ‘seeing disk’ is caused by many small angle scatterings, and hence has a two-dimensional Gaussian distribution. As the wind blows the eddies across the line of sight, the number and centroid of paths will shift randomly resulting in scintillation and image movement.



Atmospheric problems get worse the lower you look. A star 15° above the horizon will be enlarged twice as much by atmospheric turbulence as one at the zenith, regardless of whether the seeing is good (defined here as 1" star images overhead) or poor (4"). Atmospheric dispersion elongates a star into a colorful little spectrum; at very low altitudes this overtakes even poor seeing as a cause of blurry images.

Courtesy:  
Andrew T. Young

**Slow And Fast Seeing** - MacRobert notes that “Telescope users recognize two types of seeing: “slow” and “fast.” Slow seeing makes stars and planets wiggle and wobble; fast seeing turns them into hazy balls that hardly move. You can look right through slow seeing to see sharp details as they dance around, because the eye does a wonderful job of following a moving object. But fast seeing outraces the eye’s response time.”

**Twinkling** - An old piece of amateur folklore is that you can judge the seeing with the naked eye by checking how much stars twinkle. This often really does work. Most of the turbulence responsible for twinkling originates fairly near the ground, as does much poor seeing. But high-altitude fast seeing escapes this test. If the star is scintillating faster than your eye’s time resolution (about 0.1 second), it will appear to shine steadily even if a telescope shows it as a hazy fuzz ball.

**Transparency** is the measure of the clarity of the atmosphere. It always depends on altitude: even under perfect conditions a star will appear about three magnitudes fainter just above the horizon than on the zenith, and in practice horizon haze will usually increase this difference considerably. However, by selecting stars at a constant altitude it is possible to classify the transparency of any night by noting the faintest star visible with the naked eye (Limiting magnitude).

In practice, transparency as measured this way is not always determined simply by the absorption of light by water or dirt in the atmosphere. Unless the observer is situated far from any built-up area, sky-brightening caused by artificial lighting reflected off airborne particles can also make the stars appear dim by contrast. Faint aurora glows in the upper atmosphere can have a similar effect.

Extended objects such as nebulae suffer most from poor transparency, lunar and planetary detail from poor seeing, star clusters equally from both effects.

**Seeing** is a term used to indicate the steadiness of the air, as judged by the appearance of the telescope image. The two are connected by the fact that air currents are caused by masses of air at different temperatures, and the refractive index of air changes with temperature: therefore the currents cause the image to flicker. There are two basic components, often called ‘high’ and ‘low’ seeing. High seeing is affected by currents at altitudes of between about a thousand meters and several kilometers; the quality of low seeing, over which the observer has some control, depends on conditions near the ground and even inside the telescope itself. Tube currents of warm and cool air in a telescope are real performance killers. Reflectors are notorious for their tube currents. Any open-ended tube should be ventilated as well as possible.

Since seeing conditions can have a considerable influence on what is visible, they must always be recorded. The classification of seeing is likely to be more subjective than that of transparency, and expressions such as ‘good’ or ‘poor’ have little general meaning. More precise descriptions such as “boiling with steady moments’ or ‘image unsteady and rather diffuse’, should be used. Several numerical scales have also been devised. For lunar and planetary work the Antonaidi scale is widely used. For deep-sky observing many amateur astronomers use the modern version of the Pickering scale:

- I - Severely disturbed skies:** Even low power views are uselessly shaky. Go read a good book.
- II - Poor seeing:** Low power images are pretty steady, but medium powers are not.
- III - Good seeing:** You can use about half the useful magnification of your scope.  
High powers produce fidgety planets.
- IV - Excellent seeing:** Medium-powers are crisp and stable. High-powers are good, but a little soft.
- V - Superb seeing:** Any power eyepiece produces a good crisp image.

## Weather Indicators

Watch the color of the daytime sky, especially near the horizon. The bluer the sky, the darker the night will probably be. The white haze in a blue sky consists of microscopic water droplets that have condensed on tiny solid particles, primarily sulfate dust from distant factories and power plants. These particles are the precursors of acid rain. They do just as good a job of scattering artificial light at night. A deep blue sky in the afternoon should mean a transparent sky after dark.

If the weatherman predicts low humidity, that's a good sign.

A windy cold front sweeping through a city can clear out local air pollution, leaving the night marvelously dark. The windiest city and suburban nights are often the darkest. A passing rainstorm or blizzard can also leave an unusually dark night in its wake.

Poor seeing seems more likely shortly before or after a change in the weather, in partial cloudiness, in wind, and in unseasonable cold. Any weather pattern that brings shearing air masses into your sky is bad news.

After a cold front passes - often with a heavy rain or snowstorm - the sky usually becomes very dark and crystal clear but, unfortunately, very turbulent. These clear nights, when stars twinkle vigorously and the temperature plummets may be great for deep-sky observing but are usually worthless for the planets.



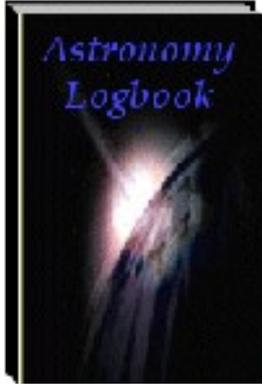
## Light Pollution

A typical suburban sky today is about 5 to 10 times brighter at the zenith than the natural sky. In city centers the zenith may be 25 or 50 times brighter than the natural background.

Where there's no light pollution the limiting magnitude is usually assumed to be 6.5, though some people can see fainter. Under such conditions, the sky is packed with stars, the Milky Way is a mass of swirling, jumbled detail and any clouds appear blacker than the sky itself.

At a limiting magnitude of 5.5, clouds are brighter than the sky because they are lit from below. The Milky Way is still easily visible but far less detailed. At limiting magnitude 4.5, the Milky Way is barely detectable as a faint, nearly featureless band. At a limit of 3.5 the Milky Way is completely invisible.

# Observing Logs



An Observing Log is a very important and often neglected tool of recreational astronomy. They're often considered inconvenient to keep, or thought to get in the way of actual observing. However, a well-kept log isn't really an obstacle, and can contribute significantly to the enjoyment of astronomy.

Anyone who observes the sky should keep a logbook. "If the hours we spend under the stars are precious, an observing log helps us remember them. Relying on memory alone just isn't good enough; as years pass, details fade away until events might as well not have happened ... So many people have told me that they would like to start an observing log but haven't gotten around to it. Yet it's easy and fun to do, and our observations will mean so much more when they're recorded accurately." - David Levy – Amateur astronomer and author

For sketching, a dark pencil, eraser and clipboard are useful, as well as sheets of paper with pre-drawn circles representing the field of view. Many observers design a standard observing form, which can be filled in at the telescope. This ensures you don't forget some important detail. After the observing session, your rough observing notes should be edited and transferred to a standard record keeping system, which will map your progress as a deep-sky observer.

## Why and When

Why would you waste time keeping a log instead of spending the time observing? There are several reasons. An observing log helps you to preserve and to relive your experiences. Re-reading old logs can bring back memories, especially small details easily forgotten. A well-kept log is a requirement to qualify for any of the Astronomical League observing program certificates. And especially important, filling in the log can help you to train your eye and mind to make you a better observer, and to get more out of your observations.

You should keep a written log during every observing session. Observing logs can contain different levels of detail. So you may wish to keep more than one to accommodate the different types of observing you do. You may want to keep a small notebook for casual sessions, and a larger one for more serious work. When working on one of the observing certificates, you should probably keep a separate log for it. The main thing is to record every observation.

A notebook is your private record of the universe. Although at first you may have to adjust to updating it, the notebook will eventually contain unique records of your journey through the universe. Astronomy offers great personal satisfaction. It would be a shame if all those wonderful memories of your involvement with astronomy simply faded away with time.

## What's in a Log

How you record your observations is up to you, but it usually makes sense to separate your log into two parts. One is for the session itself, containing information that won't change much over the course of the night. The other contains entries for observations of individual objects. For both sections, you can reduce the amount of writing you do by establishing codes for frequently repeated words or phrases. Make sure you use the codes consistently, and keep a key handy in case you forget what a particular code means.

What data should you record during your observing? That varies depending on what kind of observing you're doing. As a starting place, important data for the overall observing session would be:

*Date, beginning/ending time (UT), observing site, equipment used, Moon phase and altitude, seeing, limiting magnitude, weather conditions*

Although that seems like a lot, you only have to record some items at the beginning and end of the session, and it only takes a minute once you get the hang of it.

For each individual observation, the data to record varies depending on what you're observing, and how seriously you're observing it. Some things to consider recording:

*Object observed, location, general notes on appearance (distinctive shape, dust lanes, structure, etc.), number of stars, size of object, position angle, brightness, color, other objects in field,*

*instrument (type, aperture, and eyepiece), How hard/easy was it to find? Sketch of the object*

That really is a lot, but even so it's not exhaustive. Pick and choose what's useful to you, and periodically review your logs to see if something else should be recorded, or if something isn't useful. If you observe certain types of objects systematically, you might consider keeping separate observing logs ... Why not take rough notes in the field and then transfer the data to files on your home computer?

Even the most casual celestial sightseeing becomes more meaningful if a few notes are jotted down in a permanent record. Keeping a notebook makes a more satisfied observer. It will remind you of all the things you've seen, the way you felt while observing, and the frustration and successes you've had with the hobby. And, most importantly, it will prompt you to observe more carefully and to see more when you observe.

Sketching the object is more important than many people realize. Even crude sketches can be very effective at jogging your memory later. They are also useful for comparing against photographs for positive identification of the object or features you've observed.

## **A Happy Medium**

You can record your observations on any media that make sense for you. Examples are standard loose-leaf notebooks. Note cards, loose sheets of paper, or spiral-bound notebooks. The main thing to consider is that a useful log is small enough to carry easily, big enough to be able to find in the dark, heavy enough not to blow away in a good breeze, and readable under red light.

Some people find it useful to keep observing logs in a computer database, particularly if you have a laptop, or you already have a computer controlling your telescope. Some people like to record their observations on tape. This is probably the easiest method in the field, but it does require a functioning tape recorder with fresh batteries, and the recordings must be transcribed afterwards. Unless you are a very concise recorder, the transcribing may take longer than the original observing session.

If you are observing a particular set of objects, such as for a Messier certificate, a spiral-bound set of 3 x 5 or 5 x 7 note cards can work very well. Record a single object on each card. You can put a chart showing the location of the object on the back of the preceding card. Photocopy pages from your star atlases, draw on Telrad and eyepiece field-of-view rings, and then cut out the area containing the object and glue it onto the card.

The format of your log is not important; the content is. So any system that works is fine. Some observers prefer to draw in their logs, while others would rather compute. Some keep a diary. And some prefer the discipline of forms. Although forms insure that you remember what to put down, You might find them confining. Blank paper lets you record the unexpected. ... The free-form approach leaves unlimited room for variable star estimates, planetary drawing, times for photographic exposures and notes from other observers.

Finally, try to make the first draft of your log the last draft. If you must transcribe your logs, resist the temptation to edit the entries. If you do, you may lose some of the info, which makes the log valuable, or unintentionally add info from other sources. You'll want your observing log to be the truest record of your session possible.

# Sketching the Deep Sky

## *Capturing the deep sky as seen by the human eye*

An excellent way to train yourself to see better is to make sketches. These don't have to be works of art; the idea is to record details more conveniently than through words. An open cluster requires no artistic talent whatsoever. To give you some indoor practice, try making sketch copies of photos of open clusters. You may want to enlarge the photo with a photocopier and then sketching it from a distance.

When you sketch at the telescope, remember to note down the date and time, instrument details, sky condition and the size of the field of view. Also indicate on the sketch where north and east are. It is strongly recommended that you sketch as much as possible. While you are making the sketch, you are continually examining the object, paying close attention to certain smaller details. This close scrutiny often results in the discovery of hitherto unseen features. A sketch also serves as an excellent record of the object you are studying. Detailed objects require lengthy descriptions that may become confusing when read later. We all know the saying that a picture is worth a thousand words.

### Why sketch

A drawing of a deep-sky object makes a personal record of what was seen by the observer, and so is satisfying as an end in itself. However, drawing also forces the observer to look for more detail and, in time, this will develop a trained eye that will be useful in all types of observing. Drawing what you see through a telescope is a good way to document subtle details. By comparing renditions made on different nights, you can look for changes due to sky conditions or your growing ability as an observer.



“It's often said that a picture is worth a thousand words. Composing a thousand words takes much time and thought and still may leave the reader with the wrong mental image. So when it comes to accurate recording of scientific data, there's often no substitute for a picture.

In past centuries a scientist was necessarily a draftsman. Nowadays scientists in almost all fields rely on photography to record images, and the pencil and sketchpad no longer rank as essential scientific tools. Visual astronomy, however, remains an exception.”

- Roger Clark – Astronomer

“I've been drawing objects since I began observing, and I draw every time I go to the telescope. I approach my drawings as scientific illustrations. When you're preparing for a drawing, proper eyepiece and magnification selection are important . . . Too little power and the delineation of details can't be made out, too much power, and contrast and form in extended objects like nebulae are lost. A realistic drawing also requires proper paper selection and drawing technique, refined from hours of experience at the telescope and practice away from the telescope. As with most endeavors, skill and hard work produce quality results.”

- Michael Sweetman of Tucson, Arizona

## Equipment

If good observations are to be made, it is essential that the observer is comfortable and relaxed. An observing chair of some sort should be used at the eyepiece. A clipboard is handy for holding the rest of your drawing equipment, including your red observing light -- use a red mini-reading-lamp, with the bulb replaced by two super-bright LED's, to throw an even light over the sketching area.

The drawing paper should be illuminated by a dim red light, since a white light will destroy too much of the observer's night vision which is so essential for visual deep-sky observing. Use a 5 ½ x 8 ½ hardcover sketchbook, the paper of which should be high-quality. You could use laser-printer paper, cut in half. Before the page is divided, a checklist and circle is printed. The circle on the sketchpad represents your field of view in the eyepiece. The circle diameter should be from 50 to 100 mm.

You'll need a pen to plot stars. A pencil works better than a pen because a pen cannot convey gradations of brightness. While a normal ballpoint or fountain pen certainly won't work, a fine-point felt-tip is perfect. They make exquisitely small dots with their tiny fiber tips. For brighter stars, slightly more pressure on the pen produces a larger blob. For really bright stars, either use a thicker tipped pen, or color in a little circle. Of course, bright stars remain point sources; so don't draw them as large disks; rather as bloated spots.

A soft-leaded pencil or charcoal stick (sold at art supply shops) and an eraser are also on your shopping list. Only one type of pencil is used at the eyepiece, says Macdonald; different grades of pencil may be used to enhance the drawings indoors later on. He writes that the "ideal sketching pencil is the Ebony pencil (#6325) made by Eberhard Faber. It is coarse and soft enough to let you use just about any sketching technique you want."

Finally, you'll need a "smudge stick" or Q-tip to smudge portions of the drawing. This creates the impression of haziness and testifies to the fact that there are few straight edges and neat boundaries to deep-sky objects.

"Good drawings do not require special artistic talent or experience, but they do demand close attention, much time at the telescope, much time redrawing . . . and honesty in not recording details remembered from photographs but not positively seen"

- Roger Clark

## Drawing techniques



Before you put pencil to paper, study the object intently. Try different eyepieces to see the most detail; use various filters to enhance contrast. Use averted vision to pick out the fainter detail, letting the overall impression build up in your mind. David Coleman commenting on sketching Mars, notes "I began each drawing session by not drawing the planet! It was important for me to spend a quiet 15 or 20 minutes carefully observing. It takes practice and patience to train your eye to pick up faint detail, so try not to rush right into drawing."

Every time you sketch, you'll be impressed by how much detail you would have missed had you just looked at the object for a short while and noted a description. Fainter stars and subtle detail is revealed through extended observing. Studying the object with intense concentration and averted vision reveals more and more detail. *When you do start sketching, draw only what you see.*

The first step in sketching is to plot the positions of the brightest stars in the field of view. These stars serve as markers that keep the drawing's proportion correct. Start by plotting a prominent star in accurate relation to the field of view circle. Now plot a second one at the appropriate distance, and angle. Work from the outside, inwards. Examine the field, and pay close attention to other stars that make distinctive triangles with the two already drawn. Select a star that makes a recognizable shape, and add it in. Continue in this way by making triangles, or extended lines, or even rectangles, with new stars. In this way, a framework is erected within which fainter stars may be filled in.

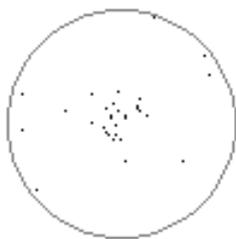
Drawing in the bright skeleton of stars should be done quickly. Spend more time imprinting the image in the mind than staring at your sketchpad. While dividing attention between the eyepiece and sketchpad, preserve as much night vision as possible by keeping your red light subdued. Limit exposure to light by spending most of your time studying the object, and then draw bits of remembered detail in short bursts. Once you've selected a spot to position a star, see if there are other triangles in which it is also involved, which can confirm its position.

If your initial framework is not accurate, rather start again. If, as you get on, you plot a star in the wrong place, make sure you correct it. If you use a pen to plot stars, it's not a simple matter of erasing. Instead, place the tip of the pen on the offending star, and draw a short (<1mm) tick away from it. When the drawing is retouched indoors, these stars are removed. A note in the margin can also draw attention to any alterations as needed. Continue plotting the fainter stars, in relation to the brighter ones, until you've added all the stars you can see.

With the stars in place, sketch the major details of the object, capturing the general shape. This later serves as a template when it comes time to fill in any subtle detail in the object's shape. It is advised that you do this very lightly; often, as you continue observing the object, this overall impression changes, especially on complex objects. This again emphasizes that prolonged observing shows detail not seen in the initial scrutiny.

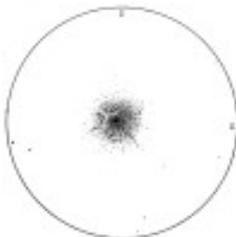
With the basics recorded, refine the sketch by adding details: the glittering of stars resolved in globulars, dark dust lanes in galaxies, and so on. Each type of object has a slightly different approach.

**Open clusters** are a favorite sketching target. Accurate placement of stars is vital, as is the faithful rendering of their brightnesses. Slowly build up the image, working from the outside inwards, using triangles and lines to position the stars. If there are an overwhelming number of stars, slightly defocus the eyepiece, which hides the fainter clutter. Then refocus to fill in the fainter members.



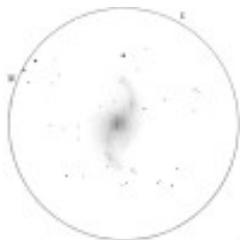
Open clusters, by the way, respond well to moonlight. While the brightened night sky drowns out fainter deep-sky objects, star clusters can be seen reasonably well. Take advantage of a clear but moonlit light to prepare sketches of open clusters. Fainter stellar members can be added in on a dark night.

**Globular clusters** can be a real challenge, especially for larger telescopes. Start by drawing the core dark, and the outer regions in successively fainter layers of pencil -- say two or three separate layers. This should give a zoned or tree-ring appearance to the sketch, but this is eliminated by careful smudging, either with a smudge stick or a Q-tip. This creates a realistic nebulous effect, if you make sure the edges fade naturally with no discernible edge. Be careful that you don't inadvertently increase the size of the object with too much smudging; rather start out slightly smaller and build up the correct size with repeated penciling and smudging. The shading should as accurately as possible reflect the brightness profile of the object; does it brighten suddenly or gradually; is the brightening slight or marked? To round off the drawing, add stars that are involved in, or very close to, the cluster. The resolved stars should be added in from the cluster edge, working inwards. Make careful note of features such as arms and clumping of stars.



Of course, in the case of a well-resolved, rich globular cluster (say Omega Centauri in a 15-inch) it's not a good idea to accurately plot every star; simply create the general impression. Don't get carried away and resort to madly peppering the cluster with stars at random.

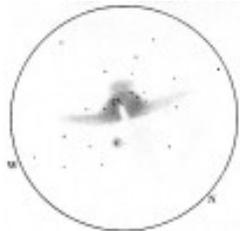
**Galaxies** are drawn in much the same way as globular clusters, starting with the darker central area (e.g. an elongated bar), working outward. Successive smudging defines the outer reaches of the galaxy, while an eraser is used to indicate obscuring dust lanes.



**Planetary nebulae** need a different approach. Many planetaries have well-defined disks that don't need smudging. Whether it's small and bright, or large and faint. First sketch in the outline of the disk. Then fill in the center so that the nebula becomes a smooth disk. Some planetaries, however, are diffuse, and their disks need to be slightly smudged.



**Diffuse nebulae** are probably the most difficult. They are often so faint that smudged pencil creates too strong an image. Rub your forefinger or cotton bud with the pencil until it is coated with a fine layer of lead. You can rub the pencil a number of times on a scrap part of the paper. When it is well coated with lead, load a cotton bud by drawing it over this "lead palette". Use this coated cotton bud to draw the shape of the nebula. Brighter portions may be enhanced by smudging with the finger.



**Dark nebulae** can be captured with the same approach, although some of them have well defined borders and are thus more like planetary nebulae. Since some of these nebulae are extremely large, a rich-field telescope, or large binoculars, show them better. Such a wide field, however, often includes a great number of brighter stars, needing a longer time to sketch accurately. You can prepare the star-field beforehand, by printing out an unlabelled star map, down to say 8th magnitude. At the eyepiece, the dark nebulae are then filled in on this framework; the idea is to sketch the nebula, not the background stars.

### Finishing the drawing

As you study the field, notice at which edge of the eyepiece the stars appear to move out. Indicate this position on your sketch - this is west. East is on the opposite side, of course. To indicate north, turn the sketch so that east is pointing upward. If you are using a Newtonian, which has two mirrors, north is to the right. If you have a one-mirror system, like a refractor with a star-diagonal, north is to the left.

Don't forget to also record the date (and time), instrument and eyepieces used, and the observing conditions that may influence the quality of the drawing.

Any drawing takes considerable time, first at the telescope, then indoors . . . A very simple subject with only a couple of field stars, such as a faint, featureless galaxy, may take only 10 minutes at the telescope. Most subjects take over 30 minutes, and complicated ones like the Orion nebula, several hours.

## **Preparing the final version**

Synthesis. Your field sketches are not supposed to be finished works of art, but rather rough drafts. For complex objects, you'll probably have made several drawings. When you've completed an evening's sketching, return indoors to prepare a better rendition of your work, under normal lighting conditions. Combine the rough sketches into a composite version and make any corrections that you noted.

The final test. When you next observe, take your sketch out to the telescope for a moment of truth. Compare it to the view in the eyepiece, looking for and noting any inaccuracies. In this way, you can ensure maximum fidelity in your final sketch. Your final sketch should readily show the casual viewer what the skilled observer was able to discern only with time and effort at the eyepiece.

## **Reproducing and displaying sketches**

Redraw your sketches if they are to be displayed or sent to other observers or observing sections. Redraw the sketch, enlarging it by representing the field of view with a 100mm circle. This time different grades of pencil are used to highlight different features. For example, a 4B (very soft) pencil is used for the cores of galaxies or very bright planetary nebulae, and an HB for faint nebulosity. It should be remembered, however, that the relevant positions and brightnesses of the stars and nebulae must be the same as in the original drawing. Otherwise, the drawing will lose its accuracy.

You may prefer to do the reproduction digitally, by scanning in the final drawing into a computer graphics file. Open clusters can be scanned in and retouched with minimum effort. Nebulous objects require a certain amount of knowledge of graphics editing software to deal with properly. This creates a permanent record with all the benefits of a digital document. If it is necessary to make a hand-drawn copy, photocopy your original, perhaps enlarging it as necessary. Nebulae, which almost always reproduce badly, can now be touched up as discussed above.

## **Practice Makes Perfect**

“Most of all, practice. There's no other way to master deep-sky observing. And don't quit on any object, no matter how vague it may look, until you've given it a good, long, thorough scrutiny.”

- Alan MacRobert

Consider this passage from *The Amateur Astronomer's Handbook* by James Muirden:

“No opportunity should be lost to train the eye to work with the telescope; to observe the same object with different powers so as to see the effect of magnification; to try to see faint stars; and to draw planetary markings. In the beginning, to be sure, this may all seem to be wasted effort; the observing book will fill up with valueless sketches and brief notes of failure. But this apparently empty labor is absolutely essential; for, as the weeks pass, a steady change will be taking place.

Objects considered difficult or impossible to see will now be discerned at first glance, and fainter specters will have taken their place. Indeed, these former features will now be so glaringly obvious that the observer may suppose that some radical improvement has occurred in the observing conditions. But the credit belongs entirely to the eye . . .”

***“The secret of success is constancy to purpose.”***

- Disraeli

# Where Do You Go From Here...

## Observing Log Index

An easy way to keep track of your observations.

## Observation Log

Observation sheets to record all the data and sketches of individual observations.

## Multiple Stars

Observation sheet for multiple star data and sketches.



## Observing Log

A simplified observation sheet.

## Observing forms from various organizations

The following forms are available at each of the respective organizations. This list is in no way complete – it is just a sampling of what is available. See the “Observing Programs and Reporting Networks” on the next two pages for more information about each organization and its websites.

*This is best way for you to make a contribution to real science.*

Samples of these forms can be found on this disk:

International Meteor Organization

A.L.P.O. Visual Meteor Observing Report

ALPO Minor Planet Section Positional and Photometric Report Form

IOTA Asteriodal Occultation Report Form

NAMN Visual Observing Form

NAMN Fireball Reporting Form

## Hours and Minutes Tables

Use this table for easy conversion of hours, minutes, seconds to decimals

**Note:** *All observation forms can be printed and/or copied for your use.*

# Observing Programs and Reporting Networks

## **Astronomical League**

<http://www.astroleague.org/index.php>

The Observing Clubs offer encouragement and certificates of accomplishment for demonstrating observing skills with a variety of instruments and objects.

Lunar, Urban Observing, Universe Sampler, Binocular Messier, Deep Sky Binocular, Southern Skies, Messier, Herschel 400, Herschel II, Arp Peculiar Galaxy, Asteroid Observing, Double Star, Meteor, Planetary Observers, Sunspotters.

## **Association of Lunar & Planetary Observers - ALPO**

<http://alpo-astronomy.org/>

The Association of Lunar and Planetary Observers (A.L.P.O) is an international group of students of the Sun, the Moon, the major planets, minor planets, meteors, and comets. Their goals are to stimulate, coordinate, and generally promote the study of these bodies using methods and instruments that are available to amateur astronomers. They provide a service for the advanced amateur specializing in particular investigations, for the novice who wishes to develop techniques and general knowledge, and for the professional scientist interested in group studies and in systematic patrols of our Solar System.

## **American Association of Variable Star Observers - AAVSO**

<http://aavso.org>

The AAVSO, the world's largest variable star organization, has been serving amateur and professional astronomers since 1911. You can contribute to this exciting field by making only a few hours of observations each month! They invite you to join their organization and become a valuable part of the continuing research in variable star astronomy.

The observing programs include:

Visual, Photoelectric Photometry, Four-Color Charge-Coupled Device (CCD)

CCD (V) Photometry of Faint Long Period Variables and Cataclysmic Variables, Eclipsing Binary,

RR Lyrae Stars, American Relative Sunspot Numbers, Sudden Ionospheric Disturbances (SIDs),

Nova Search, Supernova Search, Gamma Ray Bursters Network

## **The International Occultation Timing Association - IOTA**

<http://www.lunar-occultations.com/iota/iotandx.htm>

<http://www.anomalies.com/iotaweb/index.htm>

<http://www.lunar-occultations.com/iota/asteroids/astrndx.htm>

The International Occultation Timing Association is an organization of both amateur and professional astronomers who time the disappearance and reappearance of stars occulted by the moon. IOTA also records timings of stars occulted by asteroids, commonly known as appulses.

## **Eclipse Home Page**

<http://eclipse.gsfc.nasa.gov/eclipse.html>

NASA astronomer Fred Espenak is the world's preeminent forecaster of both solar and lunar eclipses. His Web site offers eclipse predictions, tips on observing and photographing eclipses, charts, tables, images, and many other useful resources.

## **Comet Observing**

<http://www.siliconsky.com/cometobs.htm>

<http://www.cfa.harvard.edu/icq/cometobs.html>

Here is where you'll find lots of information about comets currently of interest to amateur astronomers.

# Observing Programs and Reporting Networks

## **The International Meteor Organization**

<http://www.amsmeteors.org/>

<http://www.imo.net>

The International Meteor Organization (*IMO*) was founded in 1988 and has more than 250 members now. *IMO* was created in response to an ever-growing need for international cooperation of meteor amateur work. The collection of meteor observations by several methods from all around the world ensures the comprehensive study of meteor showers and their relation to comets and interplanetary dust.

## **IAU: Minor Planet Center**

<http://minorplanetcenter.org/iau/mpc.html>

The MPC is responsible for the efficient collection, (computation,) checking and dissemination of astrometric observations and orbits for minor planets and comets.

## **IAU: Central Bureau for Astronomical Telegrams**

<http://www.cfa.harvard.edu/iau/cbat.html>

The CBAT is responsible for the dissemination of information on transient astronomical events, via the *IAU Circulars (IAUCs)*, a series of postcard-sized announcements issued at irregular intervals as necessary in both printed and electronic form.

## **Sky Publishing - Sky & Telescope**

<http://www.skyandtelescope.com/>

This section has the latest information on current celestial events as well as links to other sites.

<http://www.skyandtelescope.com/resources/proamcollab/AstroAlert.html>

In collaboration with key organizations of amateur and professional astronomers, Sky & Telescope has established the AstroAlert e-mail news service to alert small-telescope users to significant happenings in the sky—those that involve especially rare events or require immediate follow-up observations worldwide.

## **The Astronomer**

<http://www.theastronomer.org/>

This is the home page of The Astronomer group. They produce a magazine for the advanced amateur and our aim is to publish all observations of astronomical interest as soon as possible after they are made.

## **International Dark-Sky Association**

<http://www.darksky.org>

The IDA is a non-profit, membership-based organization. IDA's goal is to be effective -- through education about (a) the value and effectiveness of quality nighttime lighting and (b) of the solutions to the problems -- in stopping the adverse environmental impact of light pollution and space debris.

“We are making a difference! “

## **SETI@home**

<http://setiathome.ssl.berkeley.edu>

SETI@home is a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI). You can participate by running a free program that downloads and analyzes radio telescope data.

## Additional Resources & References

### Internet web sites

<http://www.fortunecity.com/roswell/borley/49/>

<http://www.geocities.com/CapeCanaveral/Hangar/5170/index.htm>

The Deep Sky Database - A tool for deep sky observers

<http://www.virtualcolony.com/sac/>

Astronomy Software List (Web Links)

<http://www.midnightkite.com/software.html>

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# Observation Log

Index # \_\_\_\_\_

Object ID / Event \_\_\_\_\_

Date / Time \_\_\_\_\_ - \_\_\_\_\_ Zone \_\_\_\_\_

Location \_\_\_\_\_ Long \_\_\_\_\_ Lat \_\_\_\_\_ Elev \_\_\_\_\_

Temp \_\_\_\_\_ Humidity \_\_\_\_\_ Wind \_\_\_\_\_ Moon \_\_\_\_\_ Other \_\_\_\_\_

Transparency \_\_\_\_\_ Seeing (1-5) \_\_\_\_\_ Observer's Condition \_\_\_\_\_

Name \_\_\_\_\_

Con  
\_\_\_\_\_

R. A. \_\_\_\_\_

Dec.  
\_\_\_\_\_

Type  
\_\_\_\_\_

Mag \_\_\_\_\_

Size \_\_\_\_\_

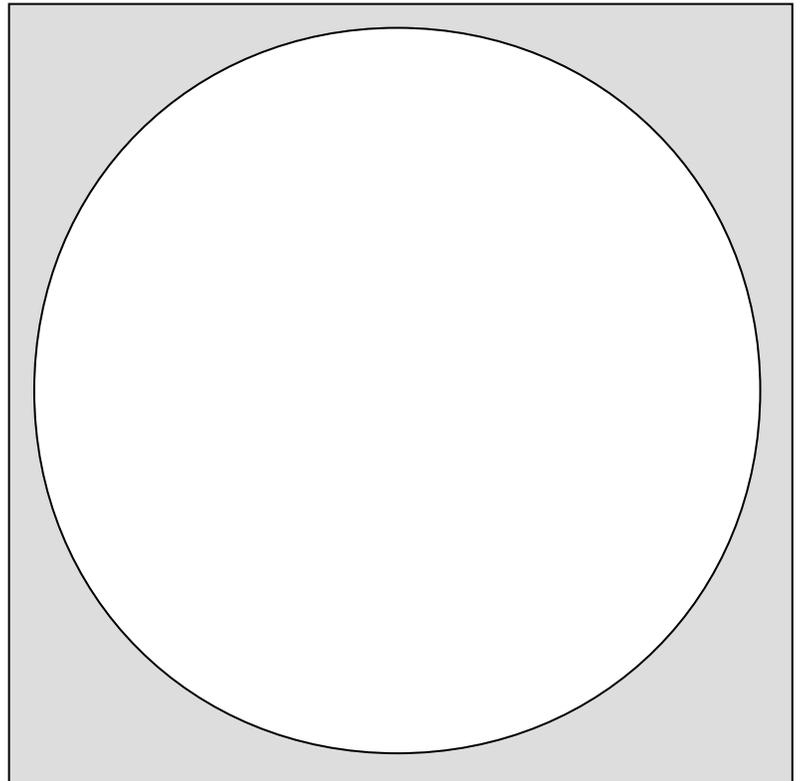
Instrument \_\_\_\_\_

Eyepiece \_\_\_\_\_

Mag \_\_\_\_\_ FOV \_\_\_\_\_

Filter \_\_\_\_\_

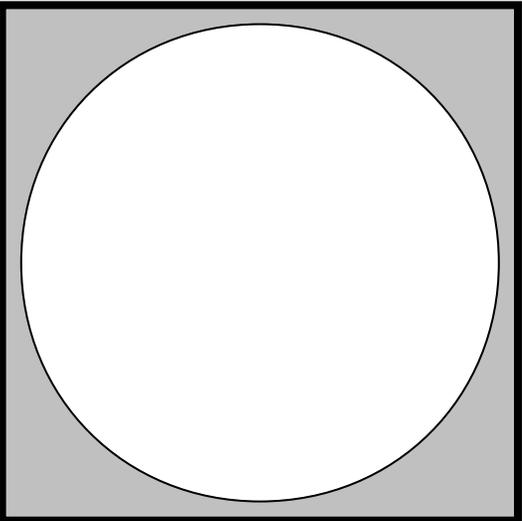
Misc  
\_\_\_\_\_

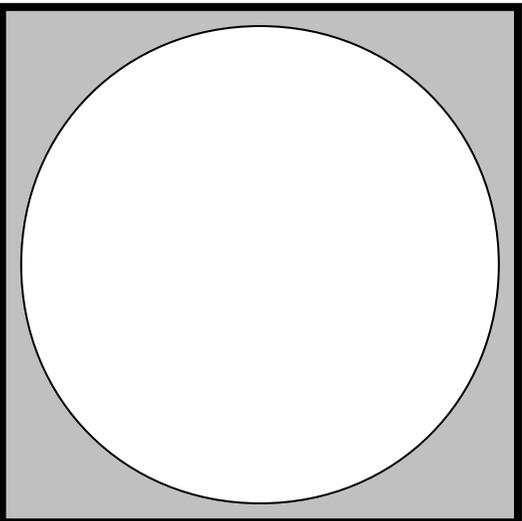


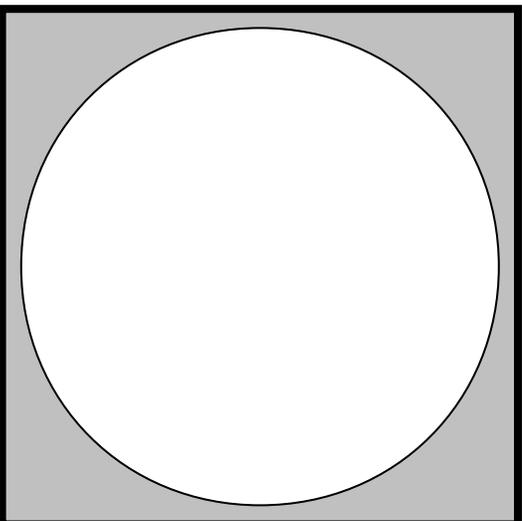
Notes:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# Multiple Stars

Index # \_\_\_\_\_

Object	_____	
R.A. / Dec	_____	
Magnitude	_____	
Separation	_____	
P. A.	_____	
Color	_____	
Date /Time	_____	
Instr / Mag	_____	
Notes	_____	

Object	_____	
R.A. / Dec	_____	
Magnitude	_____	
Separation	_____	
P. A.	_____	
Color	_____	
Date /Time	_____	
Instr / Mag	_____	
Notes	_____	

Object	_____	
R.A. / Dec	_____	
Magnitude	_____	
Separation	_____	
P. A.	_____	
Color	_____	
Date /Time	_____	
Instr / Mag	_____	
Notes	_____	

# Observing Log

Object	Date	Time	Notes
Observing Site	Instrument	Power / Filter	
	Seeing	Transparency	

Object	Date	Time	Notes
Observing Site	Instrument	Power / Filter	
	Seeing	Transparency	

Object	Date	Time	Notes
Observing Site	Instrument	Power / Filter	
	Seeing	Transparency	

Object	Date	Time	Notes
Observing Site	Instrument	Power / Filter	
	Seeing	Transparency	

Object	Date	Time	Notes
Observing Site	Instrument	Power / Filter	
	Seeing	Transparency	

## Hours & Minutes Tables

The tables below are for quick conversion of hours and minutes to the format required for some observations.

*Example:*

Date: 02/15/2001

Time: 01h 45m UT

$.04167$  (1 hour) +  $.03125$  (45 minutes) =  $0.07292$

01 (year) 02 (month)15.07292 (day)

Results = 01-02-15.07292

### Hours

1 = .04167	7 = .29167	13 = .54167	19 = .79167
2 = .08334	8 = .33340	14 = .58334	20 = .83334
3 = .12500	9 = .37500	15 = .62500	21 = .87500
4 = .16667	10 = .41667	16 = .66667	22 = .91667
5 = .20834	11 = .45834	17 = .70834	23 = .95834
6 = .25000	12 = .50000	18 = .75000	

### Minutes

1 = .00070	16 = .01112	31 = .02153	46 = .03195
2 = .00139	17 = .01181	32 = .02223	47 = .03264
3 = .00209	18 = .01250	33 = .02292	48 = .03334
4 = .00278	19 = .01320	34 = .02362	49 = .03403
5 = .00348	20 = .01389	35 = .02431	50 = .03473
6 = .00417	21 = .01459	36 = .02500	51 = .03542
7 = .00487	22 = .01528	37 = .02670	52 = .03612
8 = .00556	23 = .01598	38 = .02639	53 = .03680
9 = .00625	24 = .01667	39 = .02709	54 = .03750
10 = .00695	25 = .01737	40 = .02778	55 = .03820
11 = .00764	26 = .01806	41 = .02848	56 = .03889
12 = .00834	27 = .01875	42 = .02917	57 = .03959
13 = .00903	28 = .01945	43 = .02987	58 = .04028
14 = .00973	29 = .02014	44 = .03056	59 = .04098
15 = .01042	30 = .02084	45 = .03125	

# Observing Log

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Amateur Astronomer

**Lew Gramer**

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