# LESSON 4: TELESCOPE TYPES AND USING THEM

***What you will need:***

- *The Infinity Series Part 2: Deep Space - The dance of Gravity* video.
- Planetarium Software (Cartes du Ciel: http://www.stargazing.net/astropc/)
- A copy of the **handouts** for each student.

***Suggested Outline:***

- Show & discuss different telescope designs, mounts and accessories.
  - http://www.starizona.com/basics/basics.cfm

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- Watch Video – *The Infinity Series 2.* Second part. “How to use your telescope”. Video discusses aligning your finderscope, polar alignment, importance of dark site, letting your scope cool down, sky charts and accessories.
- **Hand out** and discuss *Quick Reference Guide of Telescope Information*
- Star Hopping
  - **DEMO:** star hopping techniques using planetarium software
- Show how to use a planetarium program. Focus on generating a map. I use Cartes du Ciel because it is free so all students can have access to it.
- **Hand out** RASC Calgary Centre’s brochures
  - Choosing & Using Binoculars
  - Choosing & Using a Telescope
- More information on telescopes and using them http://www.telescope.com/content/learningcenter/
- Astronomy terms:
  - *Beginner’s Observing Guide* pages 180 to 189
  - **Hand out** Astronomical Dictionary http://www.starshine.com/frankn/astronomy/AstroDictionary.asp

**Between Class Assignments:**

- Read *Beginner’s Observing Guide* chapters 10, 11
  - *The Importance of Binoculars*
  - *When to Buy A Telescope*
- Observe from ETUC "Constellations and Bright Stars" section.
- Download & print out a free star atlas. Bring to next class http://www.cloudynights.com/item.php?item_id=1052 or http://www.asahi-net.or.jp/~zs3t-tk/atlas/atlas.htm

# ***Student Handouts***

# Quick Reference Guide of Telescope Information

**Magnifying Power of a given eyepiece in your telescope.**

Magnification = Focal Length of Telescope ÷ Focal Length of Eyepiece

*Example:* 750mm telescope ÷ 25mm eyepiece = 30x

**Useful Magnification Range for your telescope.** (Beginner's Observing Guide pg. 93)

UMR = 0.2D to 2D

D = diameter of the objective, or of the main mirror, of the telescope, expressed in millimeters.

*Example:* for a 150mm telescope mirror
UMR = (0.2 x 150 = 30), and (2 x 150 = 300)
UMR = 30 power to 300 power

**Determining the Field of View for a given eyepiece**

FOV = Apparent Field of View of eyepiece/ Magnification

*Example:* 52° / 30x = 1.73°

**Convert degrees to minutes of arc**

Degrees x 60 = minutes or arc

*Example:* 1.73 deg x 60 = 103.8'

**Determining Image Flip in your telescope**

Knowing this is crucial to printing off custom star charts for your telescope from planetarium software.

- Refractor & Cassegrain with erecting prism – *correct view* ABC

- Refractor & Cassegrain without diagonal – *inverted*
- Straight through finderscope (really a refractor) – *inverted* ∀BC
- Newtonian / Dobsonian – inverted

- Refractor & Cassegrain with diagonal – *mirror reversed* ƆBA

# Choosing and Using Binoculars for Astronomy

Novice amateur astronomers can feel overwhelmed by the wealth of astronomical equipment available and by the vastness of the night sky. However, getting started in astronomy is easy. For example, beginners commonly are surprised to learn that binoculars are the perfect first telescope. The wide field of view allows you to find an object even if you are a little off target. The wide view can represent a significant chunk of typical constellations, meaning that it is easy to relate what you see to naked-eye views and to whole-sky maps such as those found in the *Observer's Handbook* or in *Sky News* magazine. The right-way-up, two-eye, low-power view is a still a big step away from the naked-eye view.

Using binoculars teaches skills that are valuable at a telescope including knowledge of the layout of the night sky, the orderly march of stars from east to west during the course of a night, the different constellations that are prominent during the various seasons of the year. The low power of binocular views reinforces the fact that sometimes the best magnification in a telescope is a very low one (quite different from how small department or camera store telescopes are pitched to an unsuspecting public).

### Binocular Parameters

Every binocular has a two-number designation, such as 6×30 or 10×50. The first number is the *magnifying power* or magnification. The second is the diameter of the objective (front) lenses in millimeters — the *aperture* of each lens. The bigger the objective lenses, the brighter the stars. Most astronomical objects are hard to see not because they are small and need more magnification, but because they are faint and need more aperture. Binoculars with an aperture of 50mm gather twice as much light through each lens as 35mm binoculars.

Generally, the best binoculars for night viewing have moderate magnification and large objectives; 10×50's are ideal. Magnifications higher than 10 are tough to hold steadily and lead to narrow fields of view, while the light grasp of lenses smaller than 50 mm means that fainter objects may be invisible.

Field of view typically is expressed in degrees or as a certain number of feet at 1,000 yards (for example, 325 feet at 1,000 yards). To convert feet at 1,000 yards into degrees, divide the number of feet by 52.5 (e.g. 325/52.5 = 6.2°). Most binoculars have a field of view around 6° or 7°. High-power models will shrink this while wide-angle models will take in 8° to 10°.

The exit pupil describes the width of the beam of light leaving the eyepiece. It is calculated by dividing the aperture by the magnification. All 10×50 binoculars have an exit pupil of 5mm and 7×50s have exit pupils of about 7mm.

As our eyes adapt to darkness, the pupils dilate to let in more light. Most people younger than 30 who observe under a dark, rural sky will have pupils that dilate to about 7mm. They can take full advantage of binoculars that produce an exit pupil of 7mm. By the time you're 40 or older, the pupil probably won't dilate beyond 5mm. If you use binoculars with an exit pupil wider than your pupil size, some of the incoming light won't get into your eyes and images will appear dimmer.

### Binocular Features

Most binoculars are center-focus, meaning you turn a knob in the center to focus both eyes at once. The right-hand eyepiece is also individually focusable so you can correct for differences between your eyes; this should only have to be done once. Binoculars contain a set of prisms that fold the light path internally and make the image appear right-side up. These prisms come in two varieties. Roof-prism models have straight barrels and are more compact. They tend to be more expensive and produce slightly dimmer images, making them less desirable for astronomy. Porro-prism binoculars have a zigzag shape and usually are heavier and bulkier than roof-prism models. Most higher-quality binoculars are made of BaK-4 glass instead of BK-7.

Also, look for antireflection coatings, which increase light transmission and contrast, both of which are especially important in astronomy. "Multicoating" is the best kind. In top-notch models, all glass-to-air surfaces are multicoated. We show you later how to verify that all surfaces are coated.

Rubber eyecups are useful, especially if artificial lights intrude on your observing site. Be sure that they fold down if you need to wear glasses for astigmatism.

### Selecting Binoculars

For reasonable quality, try to spend at least $100 on a pair of new binoculars. Good 10X50's will probably cost at least $160. Very good 10X50 binoculars with better antireflection coatings, improved eyepieces, larger prisms, and more rigid construction will cost more than $200. Zoom binoculars generally do not have the same optical quality as fixed magnification binoculars, so it's probably best to ignore them.

The following tests will enable you to judge the quality of any binoculars, new or used.

**1.** Pick up the instrument and compare its overall workmanship; some brands will seem better made than others will. Hold the two barrels and try to twist them slightly. If there is any play in the joints or anything rattles, reject the pair. Move the barrels together and apart; the hinges should work smoothly, with steady resistance. So should the focusing motions for both eyepieces. On center-focus binoculars, the eyepiece frame should not tilt back and forth when you turn the focus in and out.

**2.** Look into the large objective lenses with a light shining over your shoulder so the inside of the barrel is illuminated. Reject the pair if a film of dirt or mildew is visible on any glass surface. (Dust on the outside is not a problem.) Look at the two reflections of the light from the front and back of the objective lens, which will appear to float a little above and behind it. If the lens is antireflection coated, both reflections will have a blue, purple, amber, or greenish colour, instead of white. Move the binoculars around until you see a third reflection deep inside, from the first surface of the prisms. This too should be colored, not white. Then, still looking in the front, aim the eyepiece at a nearby light bulb. Move the glasses around to view a row of internal reflections. The ratio of colored to white images suggests the percentage of coated to uncoated surfaces.

**3.** Turn the binoculars around and repeat your examination of lenses and coatings from the eye end. Then, holding the glasses away from your face, aim them at the sky or a bright wall. Look at the little disks of light seen floating just outside the eyepieces. These are the *exit pupils.* If they have four shadowy edges, rendering them squarish instead of round, the prisms are too small and are cutting off some light. In good binoculars, the exit pupils are uniformly bright to their round edges. As well, they should be surrounded by darkness, not by reflections from inside the barrels.

**4.** Look through the binoculars. Adjust the separation of the barrels to match the spacing of your eyes, then focus each side separately. A filmy or gray image indicates an unacceptable contrast problem. If you have to wear glasses to correct for astigmatism, make sure you can get your eyes close enough to view the full field with the glasses on. If your glasses do not correct for astigmatism, you can take them off. If you see a double image or feel eyestrain as your eyes compensate for the binoculars' misalignment, do not buy the binoculars.

For a better test, first make sure the barrels are adjusted for the separation between your eyes, and then look at something distant through the binoculars. Slowly move them a 10 to 20cm out from your eyes while still viewing the object. It should not become obviously double. Careful! Your eyes will automatically try to fuse even a bad double image. At times, even a correctly aligned pair of images will look double for brief moments before your eyes get them into registration.

Misalignment due to flimsy prism supports is the *worst* problem of cheap binoculars; even a small knock can render a working pair worthless. Instruments that are more expensive should survive minor accidents better.

Notice the size of the field of view: the wider the better. However, the edges of a wide field usually have poor optical quality. Sweep the field at right angles across a straight line, such as a doorframe or telephone wire. Watch whether the line bows in or out near the edges. This *distortion* should be slight.

Look at sharp lines dividing light and dark, such as dark tree limbs or the edge of a building against a bright sky. Do they have red or blue fringes? No instrument is perfectly free of this *chromatic aberration,* but some are better than others.

### Under the Stars

A star at night is the most stringent test of optical quality, so try the binoculars on real stars if you can. If not, look for an 'artificial star' such as sunlight glinting off a distant piece of shiny metal. Center it in the field of view. Looking with one eye at a time, can you bring it to a perfect point focus? Or, as you turn the knob, do tiny rays start growing in one direction before they have shrunk all the way in the direction at right angles? This *astigmatism* is especially bothersome when viewing stars, and binoculars that are completely free of it can be forgiven some other faults.

Move the star from the center of the field to the edge. It will go out of focus unless you have a perfectly *flat field* and freedom from various other aberrations. As a rule of thumb, no degradation should be visible until the star is at least halfway to the edge of the field.

### Using Binoculars

Binoculars will show the Moon in crisp detail. Watch shadows creep across craters as the Moon's phase changes. View delicate earthshine glowing on the dark side of a crescent Moon. Follow the phases of Venus and track the orbital motions of Jupiter's big moons. Binoculars will help you pick out Mercury in the twilight sky and spot the faint outer gas-giant planets, Uranus and Neptune, as well as the brighter asteroids. On bright comets, binoculars magnify enough to show detail while providing a wide-enough field of view that you can see the comet's head and most or all of the tail at once.

Outside the solar system, binoculars work best on large deep-sky objects like big star clusters such as the Pleiades in Taurus or the Beehive in Cancer, which cover too much sky to see all at once through typical telescopes. Binoculars provide stunning views of Milky Way star fields and some of the larger emission nebulae that dot our galaxy's spiral arms. They'll show you the Andromeda Galaxy (M31) and the Pinwheel Galaxy (M33) in Triangulum.

Binoculars work best if you can hold them steadily. Tripod mounts are ideal, but outdoor chairs, normally used only for summer sunbathing, make good observing chairs since the armrests are perfect for resting elbows. Use a blanket or old sleeping bag to keep yourself warm while scanning the skies in this manner.

**Find out more:**

To learn more about the Royal Astronomical Society of Canada or membership in the Society contact your local Centre or the Society's National Office:

**Mailing Address:**

The Royal Astronomical Society of Canada
136 Dupont Street
Toronto ON M5R 1V2

**E-mail:**
nationaloffice@rasc.ca

**Telephone:**
Phone: (416) 924-7973
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Fax: (416) 924-2911

**Web site:**
www.rasc.ca

**Join On-line at:**
www.estore.rasc.ca

# Choosing and Using a Telescope for Astronomy

For many people, the words 'astronomy' and 'telescope' are inseparable. Many newcomers to the hobby of astronomy mistakenly believe that it is important to get a telescope as quickly as possible. Because of the large variety in telescope designs, size, and quality, choosing a first telescope can be a daunting task that has large ramifications for the budding amateur astronomer. Choose a telescope that is too large or complex to use and it may never come out of storage for a quick viewing session. Pick one that's too small, of poor optical or questionable mechanical quality, and it may kill the passion for visual astronomy altogether.

## BINOCULARS

As outlined in our companion brochure, "Choosing and Using Binoculars for Astronomy," the ideal first telescope for astronomy is actually binoculars. They give a wide field of view and a bright, right-side-up image of many interesting celestial objects. Binoculars are relatively inexpensive and versatile enough for other applications. A pair of binoculars accompanied by a good astronomy guide like the Royal Astronomical Society of Canada's *Observer's Handbook* or *Beginner's Observing Guide* is all you need to begin understanding the night sky.

## TELESCOPE READINESS TEST

> *"Space is mostly empty and you can find a whole lot of nothing with a telescope"* --- Richard Weis, former President of RASC-Calgary Centre.

If you can do the following, then you are ready to make full and rewarding use of a telescope:

- ✓ Find and name four circumpolar constellations
- ✓ Find and name three constellations seen in the southern sky in each of the four seasons
- ✓ Find and name - (a) 4 double stars (b) 4 variable stars (c) 5 star clusters (d) 5 nebulae or galaxies
- ✓ Have you seen all of the above objects with either the unaided eye or with binoculars?
- ✓ Can you find all of the above objects by yourself (using binoculars if necessary)?
- ✓ Are you familiar with at least one star atlas?
- ✓ Are you sure that you want to spend time learning how to operate a telescope so that you can explore the universe on your own?

## TELESCOPE DESIGNS

### Refractor

The refractor is what most people imagine a telescope should look like. This design uses lenses to bend, (refract) light to gather and focus light. The large lens on the skyward end is called the objective and at the other end is the eyepiece. A lens will not only bend the light, it will unfortunately spread it out into a small rainbow, obscuring fine detail. The objective lens in achromat refractors is commonly made of two or more lenses of different glass types to

help correct this problem, known as chromatic aberration. This most commonly manifests itself as faint fringes of colour around objects like the Moon or Jupiter, but it is rarely fully cured except in very expensive apochromat refractors.

Advantages: Refractors, by default, have a totally clear aperture. No central obstruction causes light to be scattered from brighter to darker areas. Thus, contrast is good in refractors. Refractors are often chosen as the premier instruments for planetary and double-star observing. Refractors are also low in maintenance.

Disadvantages: refractors are very massive and expensive in larger sizes! Residual uncorrected colour haloes form around bright objects unless apochromatic lens are used.

### Reflector


Reflectors use mirrors, coated on the front surface with aluminum, to collect and focus light. Better systems use Pyrex mirrors; cheaper telescopes have plate glass mirrors. In a Newtonian reflector light enters the tube, strikes the large primary parabolic mirror at the bottom of the tube, is reflected to the flat secondary mirror near the top of the tube, and then is reflected sideways into the eyepiece.

The Cassegrain reflector also has a parabolic primary mirror. Light is reflected off a hyperboloidal secondary mirror through a central hole in the primary mirror, allowing the eyepiece, or a camera, to be mounted at the back end of the tube.

Advantages: Reflecting telescopes suffer no chromatic aberration. Mirrors have only one surface of careful tolerances and thus are less expensive to produce than refractor objectives, which require four surfaces to be refined.

Reflectors are generally more portable than refractors of similar aperture. Newtonian designs are the most comfortable to use since the eyepiece is nearly always at a convenient height.

Disadvantages: All Newtonian reflectors suffer from coma, a defect that causes stars near the edge of the field of view to look like a comet. The smaller the focal ratio of the Newtonian scope, the greater the coma.

Reflectors are quite sensitive to being bumped or transported. A reflector that is not set up as a permanent instrument should be collimated prior to each observing session.

**Catadioptric or Compound Designs**

The Schmidt-Cassegrain and Maksutov-Cassegrain are hybrids that have a mix of refractor and reflector elements in their design to fold the optical path back onto itself, resulting in a compact tube. Like the Cassegrain reflector, a secondary mirror bounces light

through a hole in the primary mirror to the eyepiece. The Maksutov telescope uses a thick spherical corrector lens while the Schmidt corrector plate has subtle curves. Newtonian versions of both telescopes also exist.

Advantages: Most compact of the three designs; less expensive than refractors; huge assortment of after-market accessories; can be totally computer driven; very popular.

Disadvantages: More expensive than reflectors; most dew-prone of the telescope types.

**MOUNTING SYSTEMS**

An unstable mount will render the finest telescope unable to deliver quality images. If the mount is undersized, wind — the bane of most large telescopes — will not be your only enemy.

You will experience ‘bouncing’ images even when you are focusing. The test of a quality mount is its ‘damp-down factor.’ This is the time it takes an image to stabilize (for the vibrations to dampen) after the telescope is moved or refocused. Under no circumstances should the image take more than five seconds to damp down.

**Alt-Azimuth**

An alt-azimuth mount is the simplest type of telescope mount. The word derives from altitude, the distance above the horizon and azimuth, the compass heading. A telescope on this type of mount will move up and down, left and right, but will not readily compensate for the motion of the Earth.

Dobsonian mounts are a version of the alt-azimuth mount that is commonly made of wood. This simple design is very rigid and is ideal for a Newtonian telescope tube.

**Equatorial**

If Earth did not move, an alt-azimuth mount would be all that any of us would ever need. An equatorial mount readily compensates for the motion of the Earth. It does this sinceone of its axes is parallel to Earth’s spin. There are two main types of equatorial mounts; the German Equatorial, which places the telescope on one end of a shaft and a counterweight on the other, and the fork mount, which looks like a tilted alt-azimuth mount and has no counterweight. These mounts both come in two versions, manual and motorized. If you have a choice, select the motorized version.

Although most beginners chose this mount to try astrophotography, avoid any thoughts of astrophotography for now because the steep learning curve, complexity, and difficulty of this aspect of the hobby can dissuade you from more enjoyable parts of astronomy.

**GoTo drives**

A GoTo system combines a small computer with a dual-axis motor driver. GoTo drives require you to initially centre one or two stars for alignment. Most go-to telescopes manufactured today have a large database of objects from which you can select. Such systems can operate in either alt-azimuth or equatorial modes.

## TELESCOPE BASICS

In spite of the variety of designs, there are certain key functions all telescopes perform.

**Light-Gathering Power & Aperture**

Gathering light is the single most important function a telescope performs since many astronomical targets are faint. On top of this, the act of magnifying an image spreads out the light. Aperture is the size of the telescope's light-gathering element; whether it is an objective lens, as in a refractor, or its main mirror, as in a reflector. The bigger the lens or mirror, the more light the telescope will gather, and the brighter the image will be. Telescope apertures are circles, and the areas of circles increase with the square of the radius, so moving up in aperture, even modestly, can yield big results.

**Resolution**

This is a measure of how sharp and well-defined an image the telescope can produce. A telescope's ability to resolve fine detail depends on a combination of both the size of its aperture and the quality of the telescope's optics. In most cases, good resolution of an image is more important than magnification.

**Magnification**

The best magnification in a telescope is the lowest one that will show you the details (quite different from how small department or camera store telescopes are pitched to an unsuspecting public).

Avoid any cheap refractor sold on the basis of its magnification as it is almost certainly a piece of junk. These telescopes are little more than toys and will likely kill your budding enthusiasm.

Claims of 500x for such telescopes are meaningless. Normally, a well-made telescope's maximum useful magnification is usually given as 50x per inch or 2x per mm of aperture. Thus, a typical 60-mm refractor is, at best, really only a 120x telescope. So, if a low-quality, high-power eyepiece is included with the telescope, high (albeit empty) magnifications can be achieved. A 4-inch telescope can be used with eyepieces that provide up to about 200x, and so on.

Magnification can be changed by simply switching eyepieces in the telescope. To find out how much magnifying power an eyepiece gives, divide the focal length of the telescope by that of the eyepiece, using the same units, of course. So, 1200mm/25mm = 48x.

**Focal Length**

This is the effective length of the telescope's light path, from the main mirror or objective lens, to the focal point (the location of the eyepiece). The longer the focal length, the higher the magnification the telescope will produce for any given eyepiece. The telescope's focal length is usually marked on the telescope tube.

**Focal Ratio**

Focal ratio is an indication of the photographic 'speed' of the telescope's optical system, and is given by the focal length divided by the aperture. Longer focal lengths (over f/8) are 'slower,' while shorter (under f/6) are referred to as being 'faster.' For visual use, these numbers can help in deciding what telescope to buy. Most 'fast' systems are more compact than their 'slow' brethren but are more likely to be prone to optical shortcoming – chromatic aberration in refractors and coma in reflectors, for equivalent optical designs

**Accessories**

Because of the generally narrow fields of view, most telescopes require some type of aiming device. Traditionally, this has been a finder scope, a small low-power wide-field telescope mounted parallel with the main optical system. Choose one with good optics, and it will allow for pleasing views of star fields or large star clusters that are too large for the main telescope.6x30 or 8x50 are good sizes to choose.

A red dot or 'heads-up' display creates the illusion of a red reticle in the sky – showing you exactly where you are pointed. But it does not magnify, or show objects fainter than your unaided eye can see.

**Eyepieces**

In spite of the wide selection available, you really don't need more than 3 or 4 carefully chosen eyepieces, a Barlow, and perhaps a filter or two. Eyepiece designs vary primarily by focal length (magnification) and apparent field of view (AFOV). Larger AFOVs lead to wider true fields of view in the telescope. Eyepiece eye relief is a consideration, especially for glasses wearers. It is typically better in longer focal lengths.

**Ramsden** and **Huygenian** are inexpensive 2-lens eyepiece designs with narrow fields of view commonly supplied with inexpensive telescopes. These eyepieces should be replaced with better-quality eyepieces.

The **Kellner** and related **Modified Achromat** eyepieces are three-lens designs that have 40-45 degree AFOV. **Orthoscopics** are 4-element eyepieces popular for planetary work. They have a 45 degree AFOV. The popular **Plossl** eyepiece uses 4 or 5 elements, to provide a 50-52 degree AFOV. **Erfles** use 6 elements, and have a wide 60-65 degree FOV, with increasing distortions near the edge.

Newer designs, using 6 to 8 lens elements provide high-quality AFOVs of 60 to 84 degrees and some have amazing eye relief, regardless of focal length, and are a godsend to those who must wear glasses while observing.

A **Barlow lens** is a valuable accessory. Inserted between the focuser and your eyepiece, a Barlow will typically double or triple the magnification of any eyepiece. For $60-$100, you can effectively double the size of your eyepiece collection. A Barlow preserves the eye relief of your longer-focal-length eyepieces, thus reducing the amount of squinting you have to do, especially if you must wear glasses to correct astigmatism.

### Purchasing a Telescope

There is no such thing as a good, inexpensive telescope. Department store telescopes may look attractive at first glance but they are usually more of a deterrent to an astronomy hobby than a help. Their optical components are cheap and of poor quality. They are usually supplied with unstable mountings that wiggle, making it impossible to keep a steady view. They offer too much magnification with a very narrow field of view. This makes it nearly impossible to find your target. The cheap lenses give fuzzy, poor-quality images. Altogether, they are disappointing and frustrating to use.

Two good places to start are your local library and your local astronomy club. Your library should have a list of clubs and organizations to help you locate the nearest astronomy club. In Canada there is the Royal Astronomical Society of Canada (RASC) with branches in many Canadian cities. Check the RASC Web page (www.rasc.ca) for links to the RASC Centre nearest you. Try to observe through any model you're considering. Observe through as many telescopes as you can, and ask as many questions as you can think of. Ask about setup time, maintenance, accessories, and cost. If you can't find an astronomy club nearby, call or visit a local planetarium. The staff there will be aware of any astronomy clubs in your area.

When you are ready to buy a good starter telescope, contact a reputable dealer. Your local astronomy club can steer you in the right direction – they have had the experience of doing business with many different dealers and their advice will be sound! Or visit our resource directory (www.rasc.ca/resource/home.html) for a listing of Canadian suppliers of astronomical equipment.

Expect to pay from $500 to $1000 to get decent aperture and a scope that's relatively portable. Look for an 80-mm refracting telescope, or larger, on a stable mount or, 4.5", 6", or 8" reflecting telescopes. Beginners need early success, and the 6" or 8" aperture is big enough to throw up a bright pleasing image of most common celestial objects. A 6" Dobsonian is simple, cheap and will teach you a lot. The simple design is an asset, since you will want to spend your time aiming and observing with your telescope, rather than playing around with the sometimes-complicated controls on an equatorial mount. Finally, the probability that a telescope will be used is inversely proportional to its size. This seems to apply to just about everyone, regardless of experience. It is possible to get a telescope that is too big!

You will need to spend lots of quality time with your telescope. The more you look, the more you will see, and the better you will get. An experienced observer might enjoy deep-sky objects in an 80-mm refractor, while a beginner with a "light bucket" is still struggling to find the Orion Nebula.

### Find out more

To learn more about the Royal Astronomical Society of Canada (RASC), or membership in the Society, contact your local Centre or the Society's National Office:

**E-mail:**
nationaloffice@rasc.ca

**Telephone:**
Phone: (416) 924-7973
Toll free: (888)924-RASC (7272)
Fax: (416) 924-2911

**Mailing Address:**
Royal Astronomical Society of Canada
136 Dupont St
Toronto ON  M5R 1V2

**Web site:** www.rasc.ca

**Join On-line at:** www.estore.rasc.ca

# Astronomical Dictionary

A B C D E G I L M N O P Q R S T U V W Z

## A

**Albedo**
The amount of light reflected from an object.

**Altitude**
The angle above the observer's horizon. The point directly overhead is known as the zenith.

**Annular Eclipse**
An annular eclipse is a type of solar eclipse. During an annular eclipse, the Sun looks like an "annulus" or ring. The ring is visible when the Moon does not entirely cover the disc of the Sun during the eclipse. This type of eclipse happens when the Sun is at perihelion and the Moon is at apogee.

**Aperture**
The diameter of the primary mirror or lens of the telescope. The most basic thing you do in astronomy is scoop up photons, concentrate them, and project them into your eye. The bigger the aperture, the more photons you can grab. You will quickly learn that large aperture telescopes (15+ inches) used by amateur astronomers are affectionately called light buckets. Don't go buy the biggest scope in the store for your first telescope, that one will be your second telescope! I would highly recommend starting with binoculars.

**Apogee**
The point in an orbit most distant from the body being orbited

**Astronomical Unit**
The average distance between the Earth and the Sun. The AU is approximately 93 million miles (150 million kilometers). Pluto averages 40 AU from the sun. The average distance between the Earth and the Sun. The AU is approximately 93 million miles (150 million kilometers). Pluto averages 40 AU from the sun.

**Azimuth**
The angle clockwise from north along the horizon that lies beneath a star.

## B

**Bolide**
A brilliant meteor, which may explode during its descent through the Earth''s atmosphere.

## C

**Cepheid**
A variable star that scientists can use to determine how distant a galaxy, or star cluster is.

**Conjunction**
When a planet appears to come close to another planet, or star. It only appears to come close because it moves in between the other object, and the Earth.

## D

*Astronomy*

- Brazos Bend State Park
- Dictionary
- Eyepiece Calculator
- Frank's Astronomy Toy
- Large Telescopes
- Light Pollution
- Links To Astronomy Resources
- Messier Object Images
- New Moons For The Next 12 Months
- Our Planets
- Our Planets - MS Agent Enhanced (IE 3.02+ Required)
- People
- Personal Observations - 05-Apr-1997
- Personal Observations - 07-Dec-1996
- Space And Astronomy News
- Submit An Astronomy URL
- The 20 Nearest Stars
- The Constellations
- The Messier Catalog
- The Messier Catalog Search
- The Texas Star Party 1996

*Blog*

**Declination**

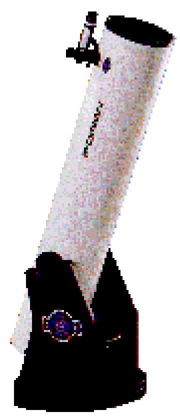
The celestial equivalent of latitude on Earth, is Declination. It is measured from the celestial equator, in units of degrees, minutes, and seconds. It increase from 0 degrees to +90 degrees at the north pole, and decreases from 0 degrees to -90 degrees at the South Pole. (See Right Ascension)

**Diffuse Nebula**

Clouds of thin widespread agglomerations of gas and dust.

**Dobsonian**

This is a common name used for a Newtonian telescope which has been mounted in a Dobson mount. Designed by John Dobson, this mount suspends the body of the Newtonian in a fork, this gives the telescope movement in the vertical. The fork is then supported by a pedestal that rotates, this allows the telescope to move in the horizontal. Designed to be simple to build, this type of mount is very popular. Mr. Dobson, by the way, does not like the name Dobsonian, he prefers to call them 'street scopes'.



**Double Star**

A stellar system consisting of two stars orbiting about a common center of mass. Also called a binary star.

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# E

**Eclipse**
The partial or complete obscuring, relative to the observer, of one celestial body by another.

**Elliptical Galaxy**
Spheroidal distributions of mostly older stars, usually without as much intersteller material found in a spiral galaxy.

**Equinox**
Either of the two times during a year when the sun crosses the celestial equator and when the length of day and night are approximately equal. The vernal (spring) equinox or the autumnal equinox.

**Eyepiece**
This is a small tube filled with bits of glass that controls the power of your telescope. There are 3 common diameters used for eyepieces: .965", 1.25" and 2". 1.25" eyepieces are very popular and widely available. Be warned that if you get a chance to use 2" eyepieces, you'll be hooked, just remember that not only are they bigger, they're more expensive. The bits of glass in the eyepiece vary in the amount of glass and their arrangement. Eyepieces have focal lengths like the telescope itself, and they range from about 4 millimeters to about 50 millimeters. Power is determined by dividing the focal length of the telescope by the focal length of the eyepiece. You will eventually acquire a collection of eyepieces, usually 3 or 4 of them spaced out in varying focal lengths.

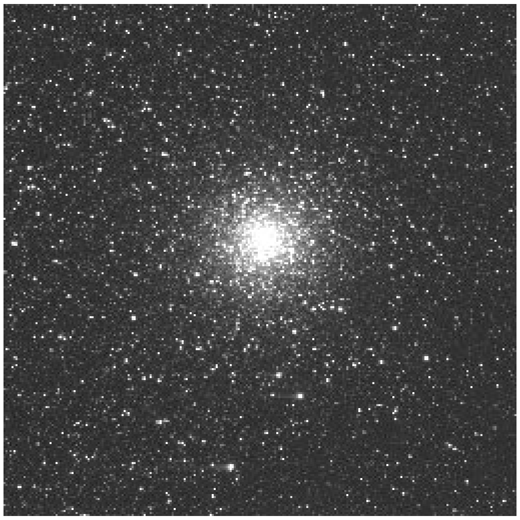
# G

**Gibbous**

When the Moon is more than half full, but less than completely full.

**Globular Cluster**

Gravitationally bound concentrations of approximately ten thousand to one million stars, spread over a volume of several tens to about 200 light years in diameter.



# I

**Irregular Galaxy**

A galaxy not does not have a regular shape like a spiral galaxy or elliptical galaxy.

# L

**Light Year**

Contrary to what some science fiction shows might lead you to believe, a light year, is not a measurement of time. It is a measurement of distance, specifically: the distance light travels, in a vacuum, in a year. At about 186,000 miles per second, this distance is approximately 6,000,000,000,000 (6 Trillion) miles (10 Trillion Kilometers).

# M

**Magnitude**

A numeric representation of the brightness of a celestial object. The higher the number, the dimmer the object. Since this measure is logarithmic, a five magnitude difference represents a 100-fold change in brightness. The Sun is a magnitude -26.8. The full Moon is -12.6. The star Wolf 359 is +13.6.

**Meridian**

The imaginary great circle that passes through your zenith from north to south, dividing the sky into east and west halves.

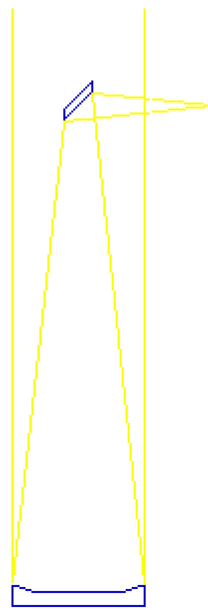
# N

**Nebula**

A cloud of gas and dust.

**Newtonian**

A type of reflector telescope. Light enters the front of the Newtonian and travels to the rear of the telescope where it is reflected and focused by the primary mirror. The light returns back towards front of the telescope where it is intercepted by the secondary mirror. The secondary mirror is suspended in the center of the telescope near the front. Mounted at a 45 degree angle, the secondary mirror then reflects the light out the side of the telescope, where it then passes through the eyepiece for viewing. The Newtonian telescope in the picture on the left, is mounted on an equatorial mount.



**Nova**

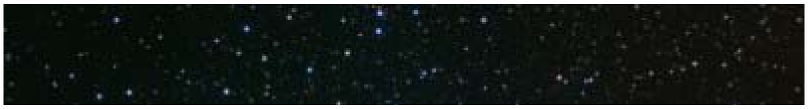
A star which suddenly flares up to many times its original brightness before fading again.

# O

**Occultation**

The covering up of one celestial body by another.

**Open Cluster**



Physically related groups of stars held together by mutual gravitational attraction. They occupy a limited region of space smaller than their distance from us and are all roughly at the same distance.

**Opposition**
When a planet is exactly opposite the Sun, so that the Earth is between them.

# P

**Parsec**
A parsec is a measurement of distance and is about 3.3 light years.

**Perihelion**
That point of the orbit of a planet or comet which is nearest to the sun.

**Perturbation**
A disturbance in the motion of an object, produced by some force additional to that which causes its regular motion; as, the perturbations of the planets are caused by their attraction on each other.

**Photometry**
Measurement of the properties of light, especially luminous intensity.

**Planetary Nebula**

At the end of the life cycle of an average star, like our Sun, the nuclear reactions in its core come to an end, while helium is burned into a shell. This makes the star expand, and causes its outer layers to pulsate. As it becomes more and more unstable, it loses mass in strong stellar winds. The instability finally causes the ejection of a significant part of the star''s mass in an expanding shell. The stellar core remains as an exremely hot, small central star, which emits high energetic radiation. The expanding gas shell is excited to shine by the high-energy radiation emitted from the central star.

**Polar Scope**
A polar scope is a small telescope that is used for aligning a larger telescope with the North or South pole star.

**Power**
In astronomy this is not the important thing that you may think it is. Do not buy a telescope because it's advertised to be 600x (power). I, on average, use 79x for my observing and to date, the highest power I have ever used was 288x. The lowest power I use, is 9x, and that's when I'm using my binoculars. Take a look at Aperture, that's where most of the action is.

**Precession**
Precession is the small wobbling motion around the Earth's axis that the Earth makes as it spins (just like the wobbling motion of a spinning top). This causes the Earth's axis to point in a slightly different direction over time. Polaris is our pole star now, but this is not permanent because of precession. Precession is caused by the gravitational influences of the Sun and the Moon and has a period of 25,800 years.

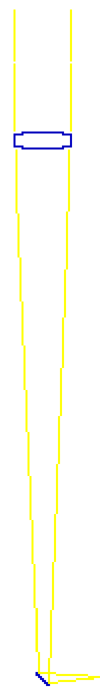
# Q

**Quasar**
A very distant immensely bright object.

# R

**Reflector**
A telescope that uses mirrors as it's means of focusing light. This one should be easy for you to remember, just keep in mind that mirrors reflect. There are many different ways to design a reflecting telescope like the Schmidt-Cassegrain or the Newtonian.

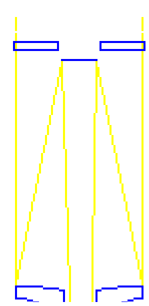
**Refractor**
A telescope that uses lenses as it's means of focusing light. A refractor offers an unobstructed aperture, that theoretically has the least aberrations of any optical system. A lower quality refractor can sometime exhibit a blue aura, around brighter objects. This chromatic aberration is reduced in apochromatic design refractors. The refractor has a maintenance advantage of being a closed system which keeps dust out of the optical tube assembly. The accompanying picture shows a refractor telescope, that is mounted on an equatorial mount.



**Right Ascension**
The celestial equivalent of longitude on Earth, is Right Ascension. It is abbreviated to RA, and is measured in hours, minutes and seconds instead of degrees. The 0 hours line of RA passes through the point where the sun crosses the celestial equator at the first moment of spring in the northern hemisphere: the Vernal Equinox. Hours in right ascension are measured eastward from this point, up to 23 hours, 59 minutes. One minute later starts the cycle over at 0 hours. (see Declination)

# S

**Schmidt-Cassegrain**
A type of reflecting telescope that also uses a lens, called a corrector plate. Light enters the telescope through the corrector plate. It then travels to the rear of the telescope where it is reflected and focused by the primary mirror onto the secondary mirror. The secondary mirror, mounted in the center of the corrector plate, reflects the light back to the rear of the telescope. The light



travels back through a hole in the center of the primary mirror, out of the rear of the telescope, where it then passes through the eyepiece. Most of the time a 90 degree diagonal is attached to the rear of this kind of telescope before the eyepiece. This diagonal allows for more convenient viewing.

**Sidereal Time**

Sidereal time is the time it takes for an astronomical object outside of our solar system to return to the same spot in the sky in one day, or approximately 24 hours. In other words, if you carefully marked the position of a star as it transits a fixed point in the sky and time it exactly until it returns to the same position you will find that this time is approximately 4 minutes less than 24 hours. The difference is explained by the fact that because the earth is constantly orbiting the Sun, the time it takes the Sun to return to the same spot in the sky is exactly 24 hours (with very small adjustments made periodically in the solar mean time).

**Spiral Galaxy**

A huge disk of stars and interstellar matter. The whole mass slowly rotates around a central hub.

**Summer Solstice**

The longest day of the year. In the northern hemispere the summer solstice usually occurs around June 22nd. See also Equinox and Winter Solstice.

**Supernova Remnant**

The gaseous remainders of a supernova.

# T

**Twilight**
There three types of twilight. Civil twilight ends when the center of the sun is 6° below the horizon. Nautical twilight ends when the sun is 12° below the horizon. Astronomical twilight ends when the sun is 18° below the horizon.

# U

**Umbra**
The dark inner part of a sunspot, or shadow.

# V

**Variable Star**
A star which fluctuates in brightness.

# W

**Winter Solstice**
The shortest day of the year. In the northern hemispere the winter solstice usually occurs around December 22nd. See also Equinox and Summer Solstice.

# Z

**Zenith**
The point on the celestial sphere that is directly above the observer.

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