OBSERVATIONAL ASTRONOMY

ASTRONOMY WITH BINOCULARS

Binoculars are one of the best tools for observing the heavens. They are inexpensive, easy to use and powerful enough to offer a real advantage over the naked eye in stargazing.

While binoculars with specifications of 6x30, 7x35, 7x50, and 10X50 are generally useful for stargazing, serious observers find 7X50 or 10x50 a good compromise between size, power and field of view.
The larger aperture works best for low light levels encountered in sky observing. The additional magnification of 10X50 results in larger image size and a smaller field of view. However, resolution is somewhat better with 7X50. Both 7X50 and 10x50 are good choices for astronomical observing.

The moon is an excellent object to observe with binoculars. You can also see the thin crescent of Venus. Other planets such as Mars and Jupiter can be observed throughout binoculars. Observations of comets, meteors and auroras are ideal with binoculars.

Binoculars are very useful in learning the constellations. The Pleiades, M45, and open star cluster is a very good binocular object, as is the Orion Nebula in the constellation Orion. Several other star clusters and nebulas are visible through binoculars.

Bibliography - "Exploring the Moon Through Binoculars and Small Telescopes" by Ernest H. Cherrington, Dover Publications, New York, 1984. “Binocular Highlights” by Gary Seronik, New Track Media, Cambridge, MA. 2006.

ASTRONOMY WITH TELESCOPES

So, you would like to buy a telescope. When you start to look for one, you may notice several things. In the first place, they come in a bewildering variety of shapes and sizes. Secondly, they will have quite a range of prices, with some of them being quite expensive. You may be lucky enough to have a salesperson to talk to, however, often he really knows very little about telescopes and will be of no help. Telescopes will usually have only one thing in common which is that they will all be advertised as able to deliver fantastically high magnification. What they don't tell you is that for various reasons, most of this magnification is useless. Don't panic! It turns out that the basic principles of the telescope are easy to grasp with only a little explanation. Let us begin by finding out what a telescope is and what it is supposed to do.

TELESCOPE BASICS

A telescope consists basically of two parts, the objective and the eyepiece. The job of the objective is to concentrate the light from distant objects and focus it into an image. The objective can be either a curved mirror or a lens. If the objective is a lens, the telescope is said to be a refractor because the lens focuses the light by the process of refraction. If the objective is a mirror, the telescope is a reflector. A newer variety of telescope uses a mirror to gather the light, but uses a type of lens to modify the light before it reaches the mirror. This hybrid type of telescope is called catadioptric (cat-uh-die-OP-trik). So we see that there are really only three primary kinds of telescopes; refractors, reflectors, and catadioptrics. The second major part of the telescope is the eyepiece. This is an optical device which magnifies the image which is formed by the objective. It consists of two or more lenses which are mounted in a small tube. It is the eyepiece which mostly determines which magnification your telescope will deliver. You change magnification simply by changing eyepieces, several of which are provided with your telescope. It is possible to purchase other eyepieces from optical supply companies as these all come in only a few standard sizes.

So which of these three major kinds of telescopes is right for you? It turns out that no one telescope does everything perfectly. Each of these basic types is best suited for different things. What kind of telescope is suited for you depends largely on things like how you will use it, how often you will have to transport it to an observation site, and how much money you can coax away from the family budget. Let's continue by considering the primary functions of the telescope.

TELESCOPE FUNCTIONS

One of the most important tasks of a telescope is its ability to gather light. This property, which is called light grasp, is important because most of the objects you would want to see are dim. What the telescope does is to gather the light over a large surface area and concentrate it into a bundle which can fit into your eye. Thus dim objects such as nebula and galaxies can be viewed. Quite simply, the greater the size of the objective, the greater will be the light grasp, and so there is a premium placed on large diameter objectives. The ability of a telescope to gather light is most often expressed as its "F" number. This is simply the focal length of the objective divided by its diameter. Telescopes with low "F" numbers (5 or less) will display bright images and telescopes with high "F" numbers (10 or more) will display dimmer images. If you want to do photography through your telescope, you would be better off if it had a low "F" number. On the other hand, a telescope with a high "F" number will usually have higher magnification and might be more suitable for planetary work. For observing deep sky objects (nebula, galaxies, star clusters), a low "F" number is preferred.

RESOLVING POWER

Resolving power is the ability of a telescope to display fine detail in its image. In general, the resolving power of a telescope goes up as the diameter of the objective goes up so here again there are advantages to having a large telescope. However, for some objects, bigger is not necessarily better. Take planets for example. Planetary observing requires good resolving power to see fine detail. The problem is that our atmosphere is a mass of sometimes very turbulent air and large diameter telescopes will resolve this turbulence so well that you can see very little of the details of the planet which you are trying to observe. A smaller instrument with good optics will often out perform a larger one for this type of observing.

MAGNIFICATION

Obviously, one of the most important functions of a telescope is controlled by its focal length and by the eyepieces which are used with it. Telescopes of longer focal length naturally magnify more than those with shorter focal lengths. However, it is possible to get almost any magnification out of almost any telescope using the right eyepiece. Magnification can also be increased with a device called a Barlow lens used in front of the eyepiece. If a magnification of 40X is good, why not increase to say 400x. After all, isn't bigger always better? The answer is definitely not. There are several reasons for this. In the first place, remember that your resolving power doesn't increase with your magnification. So as you increase power, you see an increasingly large, but increasingly fuzzy object. It's worse than that because for extended objects like nebula, galaxies, and star clusters, your image becomes increasingly dim with increased power. So now you are looking at an object which is both fuzzy and dim. Also, the effects of turbulent atmosphere become more pronounced at higher power. As a result, you will probably find that most of your viewing will be at medium to low power. So do not buy a telescope just because the manufacturer claims that it can achieve very high power. There are other factors to consider. Now, let us look at each of the major kinds of telescopes individually.

REFRACTING TELESCOPES

The refractor is the oldest form of telescope and was first used by Galileo in 1609. As explained above, it is a simple device with a lens for an objective which refracts the light down to a focal point. Refractors have one inherent problem in that the objective lens tends to act as a prism and split the light into its component colors. Thus the image you see may have color fringes on it. It is possible to correct this problem with compound lenses, and modern refractors are mostly free of this problem. However, a result of this correction is that the cost of the telescope is increased.

The refracting telescope is a good design which will outperform other telescopes of similar objective size. It is especially good for making lunar and planetary observations where resolving power is needed. The simple, unobstructed light path makes for a clear crisp image. However, refractors have some serious drawbacks, one of which is price. Those fancy, color corrected objectives are expensive. consequently, most instruments of this kind are four inches or less in diameter. Indeed, the refractor has the highest cost per inch of objective diameter of any amateur instrument. Another problem is that they do not gather much light. Most of them operate at around F 15 so that the image you see can be on the dim side. Therefore, they are not well suited for photography and for dim deep sky objects. However, for observation of bright objects such as planets, they are unsurpassed.

REFLECTING TELESCOPES

The reflecting telescope was first used by Issac Newton in 1672, consequently, they are commonly referred to as Newtonian telescopes. This telescope uses a curved mirror as an objective, and since mirrors are easier to make than large lenses, these are considerably cheaper than refractors. In fact, they have the lowest cost per inch of objective diameter of any telescope. This is one reason that they have been very popular with amateur astronomers. These telescopes do not suffer the chromatic aberration of the refractors, and gather light more effectively. This is because objective mirrors are much larger than lenses, and because they can be ground to much lower F ratios. Newtonian telescopes with F ratios between 3 and 5 are good for photography and observation of deep sky objects. On the other hand, F ratios of 8 to 12 are suitable for planetary observation. The Newtonian is a good all-around design and can be had at a relatively cheap price. However, this design too has its problems. For various technical reasons, the image quality is not as good as for a refractor of the same diameter. But remember, it is possible to buy a much larger Newtonian. Another problem is the sheer size of these telescopes, which for larger models, can result in transportation problems. Also, they do not have a sealed tube so that they require some maintenance and adjustment. Fortunately, they are easy to adjust. Finally, they suffer from an inherent optical defect called coma which is a distortion of the image near the edge of your field of view. This effect is apparent only in Newtonians of low F number and even then it is hardly noticeable.

CATADIOPTRIC TELESCOPES

Catadioptric telescopes are combination telescopes, which use a mirror as an objective and a large correcting "lens" in front of it. The purpose of this plate is to correct the defects in the curvature of the mirror. Hence these instruments are coma free. In these telescopes, the light passes through the corrector, and strikes the objective mirror. The light is reflected up front to another mirror which reflects it back through a hole in the objective. Thus a long light path is folded into a short tube. Catadioptric telescopes or "cats" as they are called, are very compact and easy to use in the field, but they do not necessarily have superior optics. In fact, their image is likely to be slightly worse than for a Newtonian of equivalent size. This is simply because they must be built to more precise tolerances. Also, they tend to have slightly less image contrast than Newtonians because light tends to "leak out" of their more complex light path. Because the light path is long the image you get is highly magnified, but the F number is high, commonly about F 10. These telescopes are often used for photography, but the high F numbers may require long tedious exposures. Despite these disadvantages, cats are becoming very popular for several reasons. For one thing, they are easy to care for. Because their tubes are fully enclosed, their optics are protected from dust contamination. They do not generally lose their optical alignment, as Newtonians can. However, anyone can align Newtonian optics, but cats must be realigned at the factory. This is an expensive proposition. Primarily, their popularity results from their portability and ease of use. In this age of city light pollution, there is a premium placed on portability and the cats are unsurpassed in this department.

WHICH ONE FOR YOU

So, which one is best for you. What you should get depends on what you want to see. The refractor is somewhat specialized and is on the expensive side unless you get a small one. They are unsurpassed for lunar and planetary viewing, and they will do very well for double stars and some star clusters. Catadioptrics are good all-around telescopes, but they are not cheap and do not have "fast" optics (low F ratio and bright image). The Newtonian telescope is substantially cheaper than these other two. It provides a good image and can be suitable for a broad spectrum of viewing. The optics can be made very "fast" with F numbers of 5 or less. Consequently, it is well suited for photography and observation of deep sky objects.

Most experts recommend that you start with a Newtonian of around six inches in diameter. These can be used for viewing a great variety of things and are relatively inexpensive. They are also small enough to be easily portable. If you want to really save some bucks, you can grind your own mirror. Another cheap alternative is to buy a mirror and build the telescope yourself. This is not as difficult as it sounds and there are plenty of books in the library to help you. If you start with a six inch Newtonian, you can have many years of enjoyable observing and you will not have made a heavy investment. This will enable you to find out what kind of observing you most enjoy. Then if you choose, you can move up to either a refractor, a cat, or a larger Newtonian.

If you would like additional information about telescopes, contact the Shreveport-Bossier Astronomical Society or your local astronomy club. They will be happy to help.