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Telescopes—A Brief Look

I Want a Telescope What Should I Get?

Variety of Telescopes

What telescope should I get? This is one of the most common questions that get asked by new Astronomers. It is unfortunately not an easy questions to answer as there are many variables that factor into the decision to get a first telescope. If you are looking to get your first telescope there are a few questions you need to ask yourself:

Are you ready? Using a telescope can be frustrating and difficult if you are not familiar with the night sky. You need to being able to find and identify objects the more you struggle to find and identify the desired target the less enjoyable astronomy will be.

What do you want to do with it? The type of telescope will depend on the types of observing you are planning on doing. Common options include Visual observing of Planets, Constellation, double stars, clusters, deep sky objects, etc..., photography-Piggy Back mounting, afocal, prime or projected imaging, Planetary imaging, deep sky imaging, will you use a dedicated astronomy camera or a DSLR.

How much are you planning on spending? Generally the best way to purchase a first telescope is to set a price, then purchase the best telescope that fits your budget for the type of observing you want to do.

Where are you planning on observing and how will you get there? This will determine the portability of the telescope and thus the size and complexity of the telescope.

What storage limitations do you have? When not in use telescopes need care and space to store them.

Once you can answer these you can move forward to find an appropriate telescope for you. Remember you are trying to find a telescope that you will actually use. This will be the best one for you.

Try to avoid just buying a telescope at a department

Telescope Terms - An Overview

Aperture

The diameter of the light collecting end of the telescope. This is measured in mm or in inches Larger aperture collects more light. Larger apertures give brighter viewing and better resolution of images.

Focal Length

The length over which the rays are focused to a point. This is measured in mm. Longer will give a clearer visual image. Longer will have a higher magnification and larger focal ratio.

Focal Ratio

The comparison of focal length to aperture. This will effect how long you will need to take keep the shutter open when imaging. Shorter f ratio means a shorter shutter speed will be needed to take an image.

Mount

This is the portion of the telescope set up that holds the telescope and determines how the telescope will be controlled. With good quality telescopes the mount is often separate from the telescope or can be easily changed from one mount to another with the use of a bracket attached to the telescope. There are two main options for mounts: Altazimuth or Equatorial. Altazimuth mounts are mounts that moves the telescope horizontally and vertically. Equatorial mounts are oriented to the celestial pole and are moved up and down in declination (To and from North and South Celestial Pole) as well as in Right Ascension or around the pole.

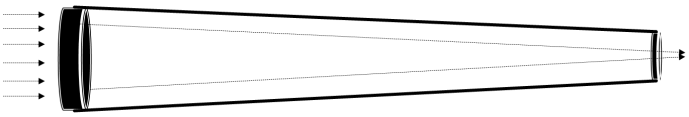
Base

The base is how the telescope's and mount is supported.

Eyepieces

Eyepieces are interchangeable pieces of the telescope you look through. They come in

Refractor Telescope



A refractor telescope uses a lens or a set of lenses to collect and bend the incoming light and refract it towards a focal point. A second lens (the eyepiece) is then used to focus the image into the eye or camera sensor to form a clear image.

Refracting telescopes have been around the longest and tend to be the traditional format that people have when they think of telescopes. Traditionally refracting telescopes have a long thin body, when compared to the aperture or diameter of the light gathering end.

Refracting telescopes give good views of the night sky. There is nothing blocking the path of light in the barrel of the telescope so, all the light collected in the front end is focused towards the eyepiece.

Refracting telescopes are nice for beginners as there is very little ongoing maintenance that is required to keep the telescope in good working order.

Skywatcher Star Travel

Many telescope manufacturers have different lines of refractors based on the quality of the telescope components. These are based on the quality and complexity of the lenses.

Generally these different lines are divided into Achromatic refractors and Apochromatic Refractors. When light is refracted not every wavelength of light is bent the same amount. As a result the image may have some separation of colour or a fringe of different coloured light around the edge of the object being viewed. The shorter the F ratio and the smaller the focal length of the eyepiece, the worse this tends to be. These are found in achromatic refractor telescopes which are cheaper to produce than Apochromatic Refractor telescopes.

Apochromatic refractor telescopes have extra lenses made with special and more expensive glass. These extra lenses eliminate the colour fringes, giving very good images for visual and photography. Unfortunately this means a significant increase in the price. (10-20x) they also make them heavier.

Refractors are limited in the apertures they are produced in, due to the dramatic increase in cost as the aperture gets bigger, as well as the dramatic length that larger aperture refractors must have to develop a clear focused image.

There are a few challenges that do arise with the use of refractor telescopes. The first is that the long tube takes quite a while to acclimatize to being outside. The larger the telescope the longer it takes to acclimatize. Until the telescope has matched the outside temperature with all of its parts, there can be some distortion due to thermal differential currents within the tube.

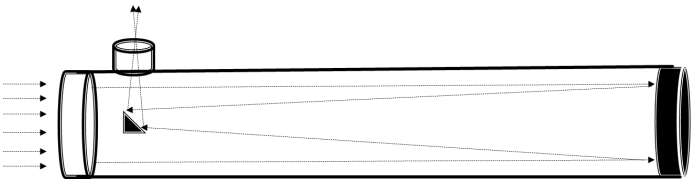
Additionally the long tube often places the observer close to the ground. To avoid being bent over refractors often employ a diagonal prism or mirror at the end where the eyepiece goes. This enables the observer to be in a more comfortable position to view. This does mean that the image has on additional flip making the image correctly oriented in one axis but inverted in the other. Be aware not all diagonals are created equal. Cheap diagonals can degrade the image making them fainter than they would be with out the diagonal.

Skywatcher BK1021 102mm

Skywatcher Evostar 80ED APO 800 600mm f/7.5 $875USD

Explore Scientific FCD100 127mm 952mm f/7.5 Carbon

Reflector Telescope



Reflector telescopes use a curved mirror at the back end of the telescope tube to collect and focus light towards the front of the telescope. The front end is open and is aimed at the target of interest. In order to view the image a small secondary mirror is placed near the front of the telescope to reflect the light through a hole in the side of the tube. This is where the eyepiece and focuser are found. Because of the 90° reflection by the secondary mirror, images in a reflecting telescope are often flipped in one axis and correct in the other.

Unlike lenses, mirrors reflect every wavelength of light the same. As every wave of light is reflected the same way, there is not colour distortion along the fringe of the image that many refractors have. This gives a nice clean image.

It is cheaper to make good quality mirrors than lenses, for this reason reflector telescopes tend to have the cheapest price per cm or inch of aperture. This makes them very appealing and a great starter telescope.

Reflector telescopes are commonly found with a dobsonian mount. A Dobsonian mount is an altazimuth mount where the base pivots with one or two arms that rise from the base to support and allow tilting of the telescope. These are simple mounts and are cheaper than the more complex equatorial that also often come with Reflector telescopes.

Starting out an astronomy session is also faster with a reflector telescope. The open tube acclimatizes faster than the other types of telescopes as the outside air can enter and cool the telescope faster.

There are a few challenges with using reflector telescopes. One challenge is telescope maintenance. Reflector telescopes can get out of alignment easier than other telescopes and require periodic or frequent collimation of the mirrors depending on the design of the reflector. Collimation does not take long but is an additional skill one should learn if they have a reflector. Another maintenance issue is the mirror surface will eventually fade and will need to be recoated and re-mirrored.

Many refractors are designed with a very narrow range of focus that is often very close to bottom of the focuser. For visual observation this is a nice feature as it gives a narrow range of where to find a focused image. For prime focal astrophotography this can be a issue as the camera's sensor is not in the same place as our eye and the sensor may not get close enough to the focal point to get a fully clear image. This may require the use of a barlow lens, or having the primary mirror moved closer to the secondary mirror.

In astrophotographs stars sometimes will have a spike or diffraction spike(s) coming off of them. These are caused by the light diffracting off/around the spider (the frame that holds the secondary mirror).

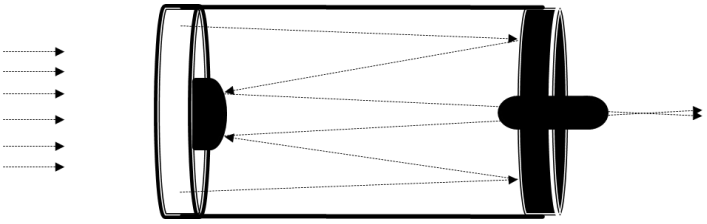
Celestron Cometron Firstscope 76mm 300mm f/4 $65USD

Meade Polaris 130 130mm 650mm f/5 $230USD

Skywatcher Heritage 130 130mm 650mm f/5 $230USD

Meade Lightbridge 12" 304mm

Compound Telescopes (Catadioptric Telescopes)



Compound or catadioptric telescopes go by many names; Schmidt-Cassegrain, Maksutov, Ritche-Cretien, they are simply a combination of element from both a refractor telescope and a reflector telescope together in one bundle.

Most involve a lens or a corrector plate at the front of the telescope. Light is then directed towards a curved mirror at the back of the telescope. This light is focused towards a secondary mirror at the front of the telescope, usually held in place by the front lens or corrector plate. The secondary mirror reflects the light back through a hole in the primary mirror to the eyepiece.

Compound telescopes tend to have long focal length in a short package due to the folding of the path of light multiple times on its path from the front of the telescope to the eyepiece. This make compound telescopes fairly compact for their apertures, improving their portability and their storage space requirements.

Although a small amount of light is lost by the blockage due to the secondary mirror and the hole in the primary mirror, the size of their aperture more than makes up for it.

The images created in a compound telescope are very clear and lack the colour aberration that occurs with refractors and lacks the formation of diffraction spikes of reflector telescopes.

The nice package of a compound telescope comes at a cost. Due to the number of optical elements (mirrors and lenses/corrector plates), compound telescopes tend to be heavier than comparable reflector and refractor telescopes. This extra weight and sealed tubes make compound telescopes slow to acclimatize to observing conditions.

The precision, advanced construction and extra optic elements of compound telescopes also tend to have a hefty price tag associated with them.

Types of Compound Telescopes

Maksutov - It uses a spherical corrector lens with a mirrored secondary mirror section and a Spherical Primary mirror

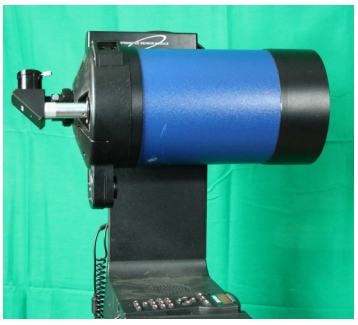
Dall-Kirkham - Uses a elliptical primary mirror and a spherical secondary mirror

Schmidt-Cassegrain - Uses a corrector plate to adjust the path of incoming light slightly and a curved parabolic primary and curved hyperbolic secondary mirror.

Ritchey-Cretien - uses a hyperbolic primary mirror and a Hyperbolic Secondary mirror .

Celestron Nexstar 4SE
102mm 1325mm f/13 $540USD

Skywatcher 127 MAK 127mm 1500mm
f/11.8 $460USD



Meade ETX LS6 152mm 1524mm f/10 $1759USD

Meade Lx90 10" 254mm 2500mm f/10
$3000USD

Bases and Altazimuth Telescope Mounts

The base is what supports the weight of the telescope and provides a platform for the mount to operate on. Bases can come in generally three forms; 1) tabletop or ground, 2) Tripod, or 3) a pier.

1)**Tabletop**-these telescopes need a sturdy object to rest on, such as a picnic table or flat rock or bench. Be aware that any movement of the base will cause the image to jiggle.

Ground-These telescope mounts sits directly on the ground. Ideally you want a firm level surface to place your ground mounted scope on. The Dobsonian Mount is the most common of this form.

2) **Tripod**-these are the classic and traditional base for most amateur telescopes. Tripods are portable and can be set up in new locations. Tripods come in different weights. Generally the heaver the tripod the better, cheaper, lighter weight tripods are prone to vibrating and take a long time for the telescope to stop shaking after bumping it or moving it. This can make observing and even focusing challenging.

3) **Pier**– a Pier is a permanently mounted post that the telescope is attached to. These limit shake and make repeated use and alignment much easier as it is always set up the same spot. They are also expensive to install accurately and limit where you can use your telescope.

Manual Dobsonian Mount
Skywatcher 8" Dobsonian $485USD Telescope and

Manual Altazimuth Mount
Mount $190USD

Orion Versago II

Manual Altazimuth Mount
Explore Scientific Twilight I Alt-Azimuth Mount

Altazimuth Mount

The mount itself comes in two forms, Altazimuth or Equatorial. Altazimuth mounts are generally easier to intuitively use as they move the telescope horizontally (azimuth) and vertically (altitude). They are great for visual astronomy and for beginners learning the art and science of astronomy. They are limited with astrophotography as there is movement in two planes inorder to track objects. This creates two problems, the first is the jiggling of movement in two directions as the mount is adjusted. The second issue is that the target object will rotate in the field of view when using a Altazimuth mount over the course of an evening.

Mount Control

There are generally two ways to control the telescope mount's movements; 1) Manually or 2) Goto.

1) Manual - a manual mount requires the observer to move the telescope them selves either with by handling the telescope directly or indirectly through the use of levers or slow motion control rods. Manual telescopes and those with a control level are sometimes a challenge to keep objects in view as we often make adjustments that are too large for the amount of movement of the object. Those with slow motion control rods are much more precise in the tracking and adjusting to follow objects in the sky.

2) Goto - These mounts are computers that once aligned with the sky can control the telescope to aim it at any target in the sky or at any coordinates in the sky and track them. Most still require alignment from the operator.

Altazimuth Goto Mount
Orion Starseeker IV mount $470USD

Altazimuth Goto
Skywatcher AZ-EQ5 Mount $1555USD

Equatorial Telescope Mounts

Equatorial mounts are designed to follow the movement of the stars and celestial objects in their apparent arcs across the sky. Equatorial mounts need to be carefully set up so that mount head is level and aligned with true north. The Equatorial mount is then set it's tilt to match the latitude of the observer aiming the telescope at the celestial pole, North or South. Once aligned in this fashion any object can be found by adjusting the declination, (angle between the celestial equator and the celestial pole) and right ascension (angle around the celestial pole). These move the telescope in arcs. As a result they can be a bit more challenging for the new astronomer to learn to use.

Equatorial telescopes are fantastic is you plan on watching the same target for more than a minute or so at a time. Once aligned and targeted equatorial mounts only require adjustment in right ascension to follow the target as it moves through the sky. Just like Alt-Az mounts there are multiple ways to control the telescope mount's movements; 1) Manual, 2)Tracking drive or 3) Goto.

1) Manual - a manual mount requires the observer to move the telescope them selves either with by handling the telescope directly or indirectly through the use of levers or slow motion control rods.

2) Tracking Drives-a tracking drive is an equatorial mount with a motor to drive the right ascension movement to match the rotation of the Earth when the telescope is perfectly aligned to the Celestial pole. These still require the operator to know what they are looking at an how to find it manually. Some have drives on both right ascension and declination which allow the operator to control the telescope with a remote.

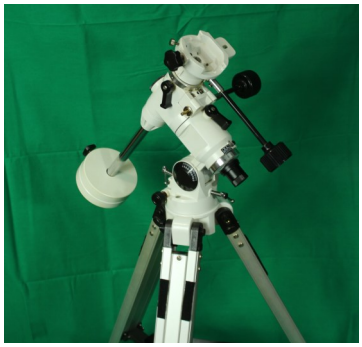
3) Goto - These mounts are computers that once aligned with the sky can control the telescope to aim it at any target in the sky or at any coordinates in the sky and track them. Most still require alignment from the operator in order to work accurately.

Equatorial mounts come in a variety of styles and weights. Many cheap telescopes come with an EQ1 or EQ2 mount. These are the bottom end of the telescope market and tend to be poorly constructed, flimsy and frustrating to use. The Mount needs to match the size of the telescope mounted to it. Many cheap department store telescopes come with mounts that are over weighted. After any touch to or movement of the telescope shakes the telescope a lot and they tend to take a lot of time to stop shaking, making it difficult to focus or even view images through the telescope. Generally for most mount manufacturers, the larger the EQ number (EQ1, EQ2, EQ3, EQ4, EQ5, EQ6, etc…) the heavier and sturdier the mount will be.

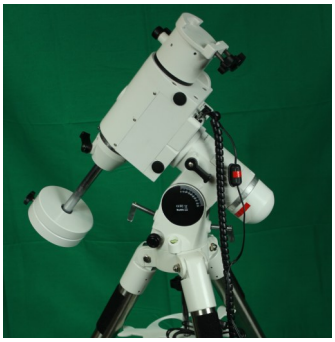
Equatorial telescopes require more steps to get them ready. To work properly all Equatorial telescopes need to be level and the mount needs to be aimed at and aligned to the celestial pole. The better this alignment the better the mount will track celestial objects. Many Equatorial telescope come with a polarfinderscope to make this alignment easier and more accurate.

The telescope then needs to be balanced on the mount. With the lock off so the telescope can spin freely the telescope needs to be adjusted in the rings and/or in the mounting bracket so that the front and back are balanced. Once the telescope is balanced the counter weights need to be adjusted so they balance the weight of the telescope.

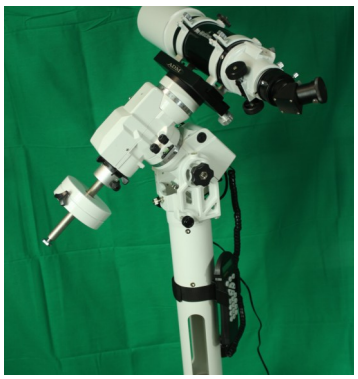
Manual EQ3 Mount
Often included with telescope



Equatorial Manual Mount Skywatcher EQ3 Mount $290USD

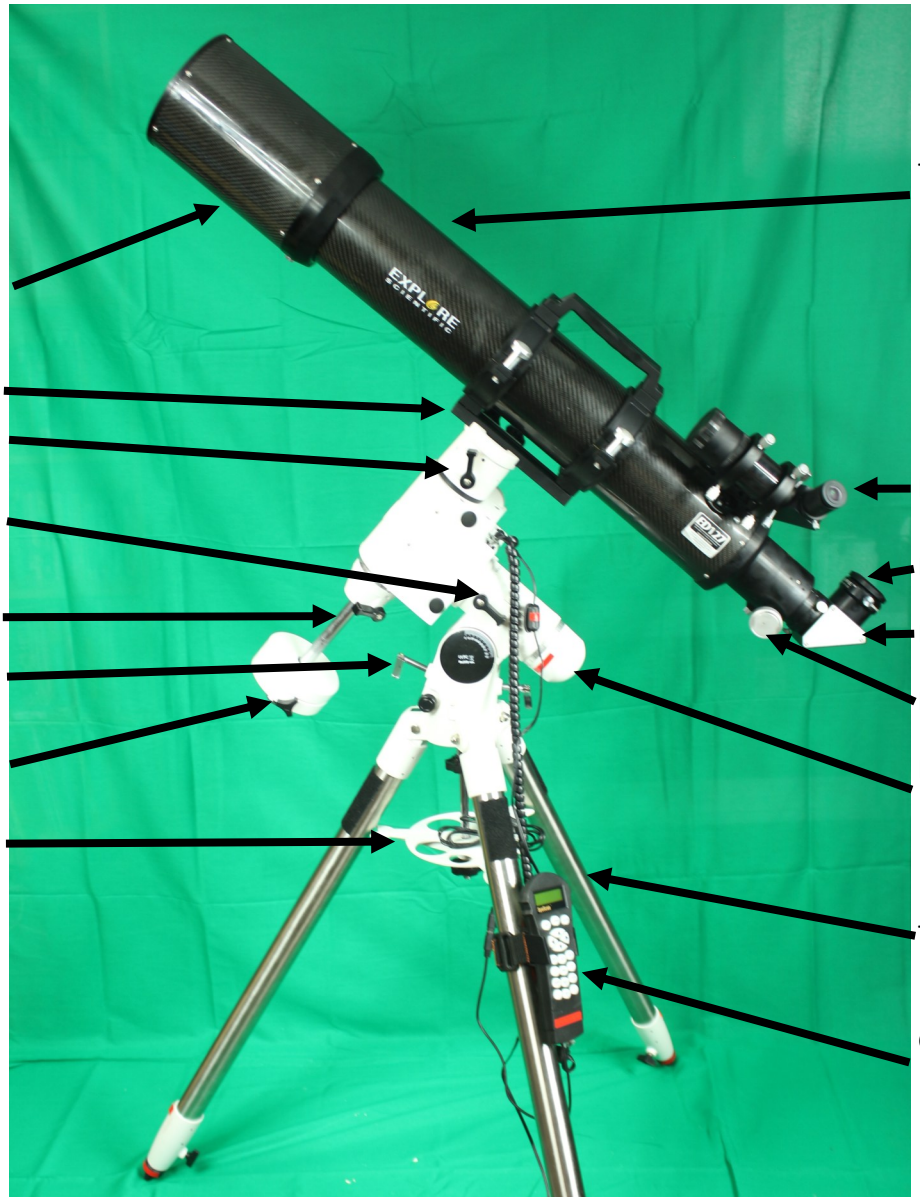


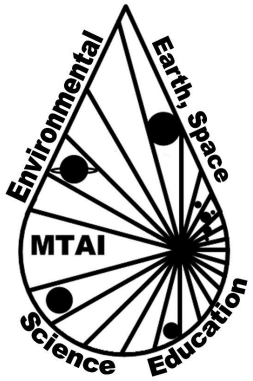
Equatorial Goto Mount
Skywatcher HEQ5 mount $1225USD



Equatorial/Altazimuth Convertible Goto
Skywatcher AZEQ5 $1555USD

Parts of A Telescope





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