A Guide to Telescopes

How to choose the right telescope for you

Telescopes

What is a Telescope? A Telescope is an instrument that aids in the observation of remote objects by collecting electromagnetic radiation (such as visible light).

The word "*telescope*" (from the Greek τῆλε, *tele* "far" and σκοπεῖν, *skopein* "to look or see"; τηλεσκόπος, *teleskopos* "far-seeing") was coined in 1611 by the Greek mathematician Giovanni Demisiani for one of Galileo Galilei's instruments presented at a banquet at the Accademia dei Lincei Galileo had used the term "perspicillum".

Optical Telescopes. An optical Telescope gathers and focuses light mainly from the visible part of the electromagnetic spectrum (although some work in the infrared and ultraviolet).

Types of Optical Telescopes

Refracting Telescopes (Dioptrics):

- **Achromatic**
- **Apochromatic**
- **Binoculars**
- **Copyscope**
- **Galileoscope**
- **Monocular**
- **Non-Achromatic**
- **Superachromat**
- **Varifocal gas lens telescope**

Reflecting Telescopes (Catoptrics):

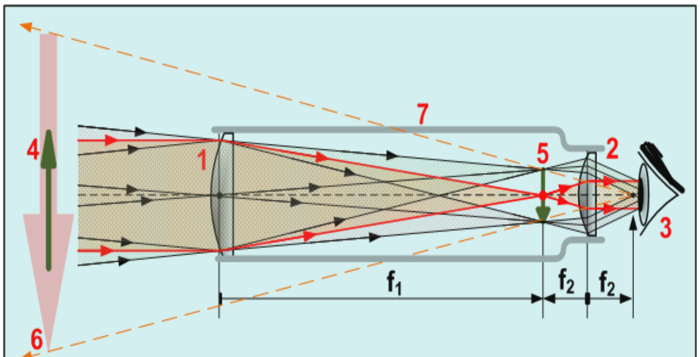
- **Cassegrain telescope**
- **Gregorian telescope**
- **Herrig telescope**
- **Herschelian telescope**
- **Large liquid mirror telescope**
- **Newtonian**
  - **Dobsonian telescope**
- **Pfund telescope**
- **Schiefspiegler**
- **Stevick-Paul telescope**
- **Toroidal reflector / Yolo telescope**

Catadioptric Telescopes:

- **Argunov-Cassegrain**
- **Catadioptric dialytes**
- **Klevzov-cassegrain telescope**
- **Lurie-Houghton telescope**
- **Maksutov telescope**
  - **Maksutov camera**
  - **Maksutov-Cassegrain telescope**
  - **Maksutov Newtonian telescope**
- **Modified Dall-Kirkham telescope**
- **Schmidt camera**

Refracting Telescopes:

All refracting telescopes use the same principles. The combination of an objective lens **1** and some type of eyepiece **2** is used to gather more light than the human eye could collect on its own, focus it **5**, and present the viewer with a brighter, clearer, and magnified virtual image **6**.



Schematic of **Keplerian** refracting telescope.

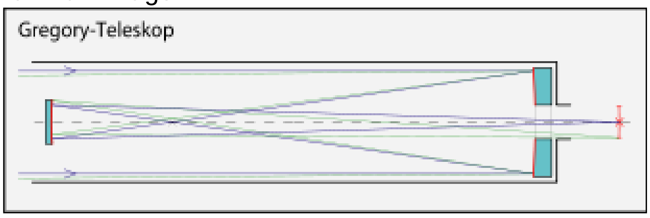
The objective in a refracting telescope refracts or bends light. This refraction causes parallel light rays to converge at a focal point; while those not parallel converge upon a focal plane. The telescope converts a bundle of parallel rays to make an angle α, with the optical axis to a second parallel bundle with angle β. The ratio β/α is called the angular magnification. It equals the ratio between the retinal image sizes obtained with and without the telescope.

Refracting telescopes can come in many different configurations to correct for image orientation and types of aberration. Because the image was formed by the bending of light, or refraction, these telescopes are called *refracting telescopes* or *refractors*.

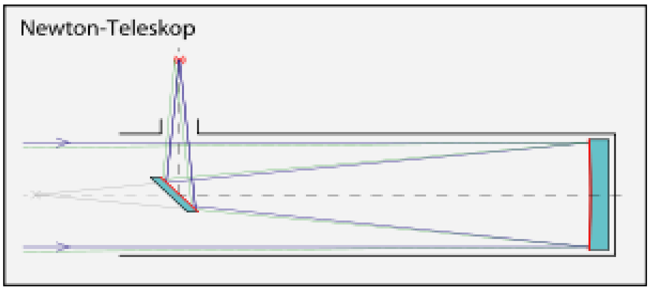
Reflecting Telescopes:

A **reflecting telescope** (also called a **reflector**) is an optical telescope which uses a single or combination of curved mirrors that reflect light and form an image.

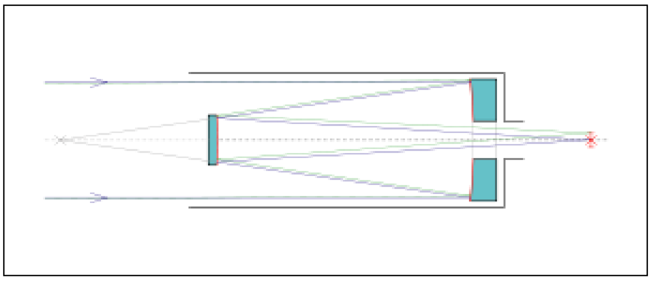
Gregorian: The Gregorian telescope employs a concave secondary mirror that reflects the image back through a hole in the primary mirror (This produces an upright image).



Newtonian: A Newtonian usually has a paraboloid primary mirror but at focal ratios of f/8 or longer, a spherical primary mirror can be sufficient for high visual resolution. A flat secondary mirror reflects the light at the side of the top of the telescope tube (It is one of the simplest and least expensive designs making it the most popular).

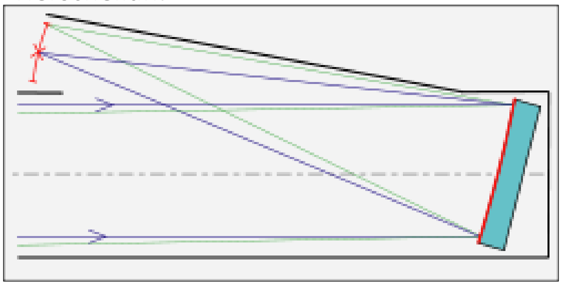


Cassegrain: The Cassegrain telescope has a parabolic mirror and a hyperbolic secondary mirror that reflects the light back down through a hole in the primary. Folding and diverging effect of the secondary mirror creates a long focal length with a short tube length.

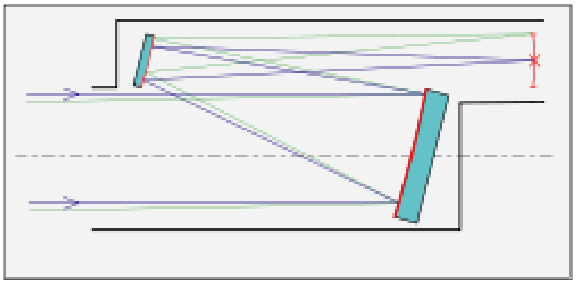


Other Reflectic designs:

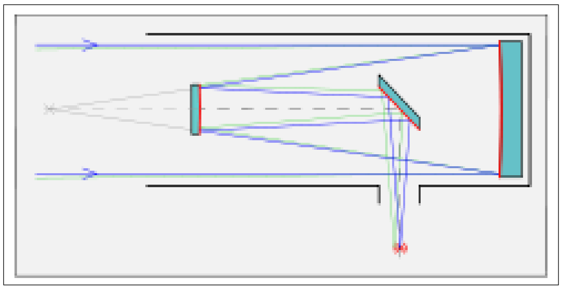
Herschelian:



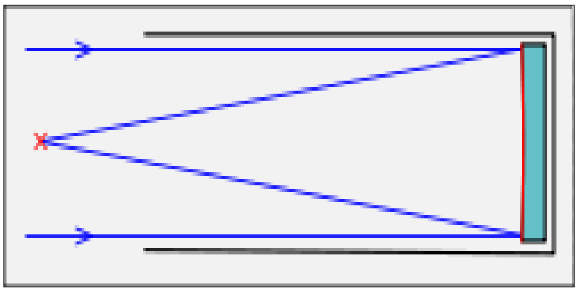
Yolo:



Nasmyth/Coudé Light Path



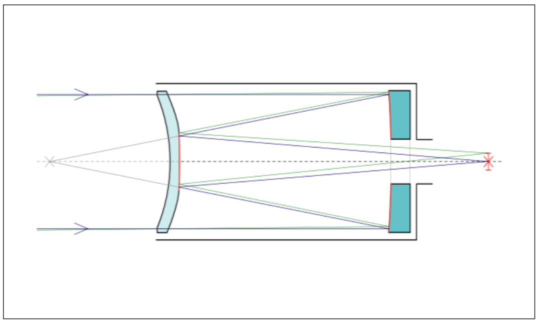
Prime Focus:



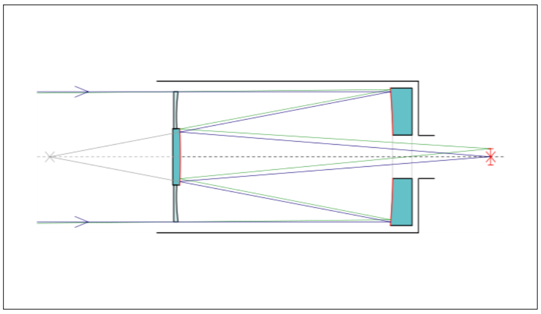
Catadioptric Telescopes:

Catadioptric telescopes are optical telescopes that combine specifically shaped mirrors and lenses to form an image. This is usually done so that the telescope can have an overall greater degree of error correction than their all lens or mirror counterparts with a consequently wider aberration free field of view. Their designs can have simple all spherical surfaces and can take advantage of a folded optical path that reduces the mass of the telescope, making them easier to manufacture. Many types employ "correctors", a lens or curved mirror in a combined image-forming optical system so that the reflective or refractive element can correct the aberrations produced by its counterpart.

Maksutov–Cassegrain: Maksutov–Cassegrain telescopes are the most commonly seen design that uses a meniscus corrector, a variant of the Maksutov telescope. It has a silvered "spot" secondary on the corrector making a long focal length but compact (folded optical path) telescope with a narrow field of view**.** The combination of the corrector with the silvered secondary spot makes Maksutov–Cassegrains low maintenance and ruggedized since they can be air sealed and fixed in alignment (collimation)



Schmidt–Cassegrain telescopes: Schmidt-Cassegrain telescopes are one of the most popular commercial designs on the amateur astronomical market. The design replaces the Schmidt Camera film holder with a Cassegrain secondary mirror making a folded optical path with a long focal length and a narrow field of view.



Other things to know:

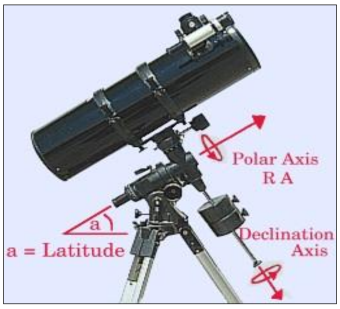
Dobsonian Telescope:

A **Dobsonian telescope** is an **alt-azimuth** mounted Newtonian telescope design popularized by the amateur astronomer John Dobson starting in the 1960s. Dobson's telescopes featured a simplified mechanical design that was easy to manufacture from readily available components to create a large, portable, low-cost telescope. The design is optimized for visually observing faint deep sky objects such as nebulae.

Alt Azimuth Mount:

Dobsonian Telescope:

Equatorial Mounts:



An equatorial mount is a mount for instruments that follows the rotation of the sky (celestial sphere) by having one rotational axis parallel to the Earth's axis of rotation. This type of mount is used for astronomical telescopes and cameras. The advantage of an equatorial mount lies in its ability to allow the instrument attached to it to stay fixed on any object in the sky that has a diurnal motion by driving one axis at a constant speed. Such an arrangement is called a sidereal drive.

Flex Tube (sometimes known simply as collapsible tube assemblies): “Classic” design tube assemblies would require a large van for transport. Designers started coming up with collapsible variants that could be brought to the site with a small car. This innovation allowed the amateur astronomy community access to even larger apertures

GoTo Mounts: In amateur astronomy, "**GoTo**" refers to a type of telescope mount and related software which can automatically point a telescope to astronomical objects that the user selects. Both axes of a GoTo mount are motor driven and are controlled by either a microprocessor-based integrated controller or a personal computer, as opposed to the single axis semi-automated tracking of a traditional clock drive mount. This allows the user to command the mount to point the telescope to a right ascension and declination that the user inputs or have the mount itself point the telescope to objects in a pre-programmed data base including ones from the Messier catalogue, the New General Catalogue, and even major solar system bodies (the Sun, Moon, and planets).
Like a standard equatorial mount, equatorial GoTo mounts can track the night sky by driving the right ascension axis. Since both axes are computer controlled GoTo technology also allows telescope manufacturers to add equatorial tracking to mechanically simpler alt-azimuth telescope mounts.

How an image is seen through a telescope:

Normal Image:

Image seen through a refractor:

Image seen through a reflector:

Telescope Magnifications

As a general rule of thumb, a telescope is capable of magnifying an object approximately 50x-75x per inch (or 2x-3x per mm) of aperture (objective diameter), so a 4” (100mm) telescope has the potential to magnify approximately 200x-300x. The optical quality, configuration of the telescope and seeing conditions however, will be deciding factors as to what useful magnification a particular telescope can achieve. Atmospheric turbulence usually restricts practical magnifications to a maximum limit of about 300x, or slightly more in rare cases. Above the magnification limit, the image becomes too blurry for useful observing.

It should be carefully noted that for many astronomical observations high magnifications are not necessary and much better results are often achieved by using low power.

The magnification ranges quoted for many of the telescopes we stock are simply those achievable with the standard accessories, and can be increased or decreased as necessary with optional accessories, within the boundaries of the telescope’s capability.

Resolution

The most important factors in a telescope are the aperture (or light gathering capability), and the quality and accuracy of their optics. The aperture determines the telescope’s ability and accuracy of their optics. The aperture determines the telescope’s ability to resolve small or distant objects and to reveal fine detail. Resolution can be defined as how much detail a particular telescope can see. If the diameter of the aperture is twice as big on a similar telescope, then the resolving power should be twice as good.

Resolution is stated in arc-seconds and there are sixty arc-seconds in an arc-minute and sixty arc-minutes in a degree.

In short: The bigger the aperture, the higher the resolution and therefore the better the image!