

Telescopes

This is a beginners guide to the sometimes bewilderingly different types of telescopes available to amateurs. But first things first, all astronomical telescopes invert images. Some laterally reverse (mirror image) them too! The reason is simple, the more lenses used, the more the image is degraded. So inverting lenses (used in terrestrial telescopes) are omitted.

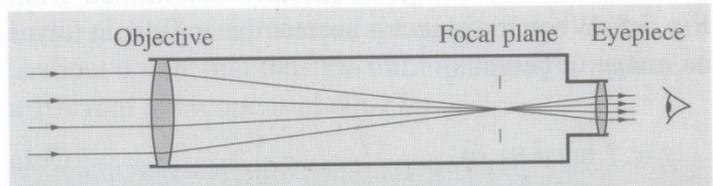
The problem with all telescopes is that of aberrations. There are two types, Spherical (which distorts the shape of the image) and Chromatic (which distorts the colour rendering of the image). As a general rule, the more expensive the telescope, the better are the aberrations!

Magnification is generally a bad word in astronomy. Light Gathering Power (LGP) is the really important factor, magnification is only useful when enough light has been gathered. The more you magnify an object, the dimmer it becomes. LGP is proportional to the diameter of the object lens or main mirror. This is why decent telescope data concentrates on diameter. Magnification is seldom mentioned on such data sheets (except possibly the maximum magnification advisable)! Many amateurs like observing deep-sky objects (aka "faint fuzzies"), so LGP is the top priority. Some of these are extended objects, so a high magnification with the attendant small field of view is just not practical.

The f-number is the same as for a camera. For a telescope it is obtained by dividing the focal length by the aperture. The lower the f-number the "faster" is the optical system. Important for those interested in imaging.

Refractor

The very simplest telescope is the refractor, as used by Galileo. It has an Objective lens and an Eyepiece (Ocular).



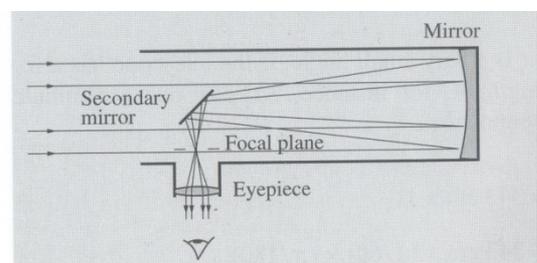
With simple lenses it suffers badly from both types of aberrations. Typically with a blue ring around the outside of the field of view and colour fringing around bright objects

Many manufacturers use compound lenses, two or more lenses using different types of glass (different refractive index) bonded together. This greatly improves the aberrations (but costs more!). Achromatic telescopes greatly improve chromatic aberration, while Apochromatic do even better, leaving very little residual spherical aberration too.

At the inexpensive end of the market, these are good. While they are generally not popular with the more expensive designs, they can be very good indeed, if somewhat limited in objective diameter (due to cost and weight).

Reflector

This uses a main mirror, as the name suggests. Mirrors reflect all colours the same, so chromatic aberration isn't usually a problem. But spherical aberration still is. There's also another problem, collimation. This requires that all reflecting surfaces



are correctly aligned.

The simplest design is the Newtonian (Invented by Sir Isaac), which uses a parabolic main mirror and a flat one for the secondary. It is a very popular type. The secondary is held by a “spider” which can cause diffraction spikes with bright stars. Also, the secondary mirror does obstruct some light getting to the primary mirror. This type does suffer from Coma, off-axis flaring of images. But can be fitted with a coma corrector to improve the optics.

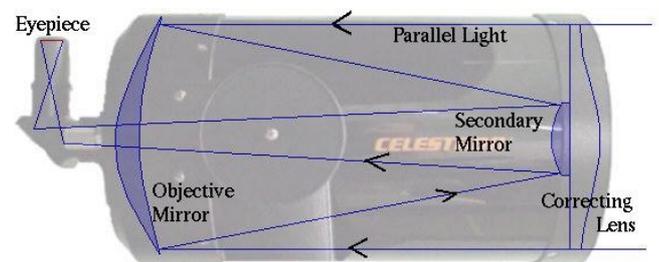
It is a very versatile type and much favoured by many amateurs. The right-angle ocular near the top of the tube makes for convenient viewing and a low mounting height.

Catadioptric

This is a type, of which there are many variants, that combines both lens and mirror in an attempt to improve all aberrations.

The most popular is the **Schmitt-Cassegrain**.

Grinding a parabolic mirror is expensive, but grinding a spherical mirror is fairly inexpensive but subject to unacceptable spherical aberration. So a Corrector Plate (basically a very specially shaped lens) is included early in the optical train. The secondary mirror reflects the image back through a central hole on the primary mirror.



Because of the short tube (due to the folded optics) this is a very convenient telescope for portable use. The right-angle viewer also makes this a comfortable design to use.

There are a number of other variants based on similar optical paths, such as Maksutov, Ritchey–Chrétien, etc. They are all Cassegrain types (optical path exits through a hole in the primary mirror), but the details go well beyond the scope of this simple introduction.

All these variants mirror-image as well as inverting objects. It makes using star charts quite interesting!

Finders

Most finderscopes are simple refractors, often fitted with a cross-wire reticule in the (usually) permanent ocular. Many also fitted with a right-angle adaptor too. The usual mounting for a finderscope is somewhere on top of the main tube, hence the right-angle adaptor for convenience. Many finderscopes have a fixed focus at infinity, some of the better ones allow some focussing for individual eyes.

Finderscopes should be aligned, often by the adjustment screws on the tube rings, such that the centre of view is very close to that of the main telescope. Their field of view is significantly wider than the main scope at its lowest magnification, hence the use as a finder.

Even for computer-controlled alignments, a finderscope is of use in acquiring the first star of a 3-star alignment.

A popular alternative to the simple refractor (and cheaper too) is the Red Dot finder. This is a small device, similarly mounted on the main tube as a finderscope. This projects a red dot at infinity in a small unmagnified viewfinder. After aligning with the main tube, it serves very well as a finder. This finder incorporates a switch for the small battery, often incorporating a dimmer too. Two-axis alignment screws are used to align the red dot to the main centre of field.

When aligning either type of finder, select a bright star in the main telescope, centre it in the field of view (see reticule ocular) and align the finder to the star. Once done, it is seldom necessary to redo this.

Oculars

There are two standard eyepiece sizes, 1.25" and 2". The focal length of the eyepiece determines the magnification of the optical system. Magnification is simply the Focal Length of the telescope divided by the Focal Length of the ocular.

There are many types of ocular, each having its good and bad points. Eye Relief is important for many observers, especially if spectacles are worn. Most oculars have a rubber cup, usually folded back. This is particularly useful with spectacles.

As well as many different optical types, there is a wide range of prices. Usually the Plössl at the inexpensive end of the range, up to the stunning Nagler types. Sometimes a Barlow Lens (or equivalent) is inserted into the optical train prior to the ocular. This magnifies the image, at cost of reducing the image brightness. But mostly this is used for planetary observing or resolving double stars.

One very useful ocular is the illuminated reticule type. When using a computer-controlled mount, getting the 3-star alignment is difficult without one. Alignment stars need to be exactly centered in the field of view or the overall alignment will fail. Use of an illuminated reticule virtually ensures a good alignment. A variable-brightness red LED illuminator is used to illuminate the crosshairs. No need for a more expensive one with an adjustable reticule, but ones with double crosshairs seem to be easier to use.

Camera adaptors, optical switches, etc., are beyond the scope of this simple introduction.

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