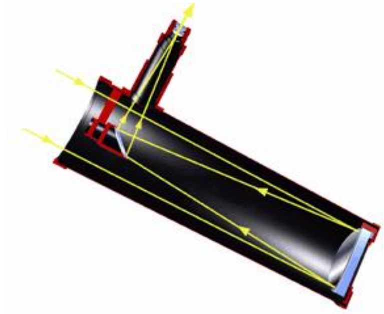
CHOOSING A TELESCOPE

Different Types of Telescopes

REFLECTORS - ** Focus light to a single point by ***reflecting* light rays off the surface of a curved mirror. Hence their type name, more often called Newtonians today, after the mane who pioneered the design - Sir Isaac Newton.



Mirrors are made by coating the front surface of a concave piece of glass with a reflective material, so that rays of light rays entering the telescope don't pass through the glass, but are ***reflected*** off the mirror, without introducing ay false "colours'.

The shape of high focal ratio mirrors – F9 and higher – in small reflectors, match the surface of a sphere, but in large reflectors with focal ratios of f8 and below, not all light rays reflected by the mirror arrive at the same focal point. "***Spherical aberration"*** – peculiar to spherical surfaces - cause the rays reflected by the perimeter of the mirror, to focus at different points from the centre, thus producing low contrast images.

This characteristic is overcome by giving the mirror's shape a parabolic curve during polishing. All reflected light rays then focus at the same point, towards the front of the optical tube, where the light is redirected, and re-focused onto the lense of an eyepiece.

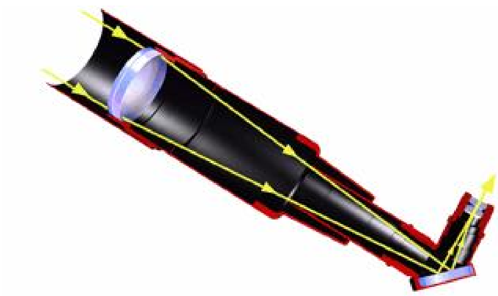
This is achieved by a flat, oval shaped secondary mirror, mounted inside the tube, where light rays enter, interrupting the rays reflected to the focal point. It's surface is set at 45 degrees to the reflected light, just in front of the focal point, which redirects the reflected image onto eyepieces at right angles to the reflected light. Some light entering the tube is obstructed, but has minimal effect on the image seen at the eyepiece.

The amount of light prevented from reaching the foal point does affect diffraction patterns with a minute loss of contrast, but secondary mirror itself is not visible in the focused image.

Advantages are more convenient viewing and stability, as reflectors are mounted closer to the ground, and they are less expensive, having only two surfaces manufacture and install in a simple tube.

Disadvantages are Large tubes on German Equatorial Mounts are less stable and susceptible to wind vibrations, and light clamping of both mirrors – to protect the glass - means they need regular collimation.

REFRACTORS - Use glass lenses to bend, or refract rays of light to a focal point at the rear of a sealed optical tube. Hence the name.

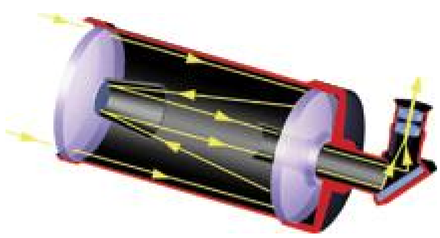


Refractors have several advantages over other designs. An enclosed tube prevents the entry of dust and moisture, and their fixed optical lenses don't require regular collimation.

With no central obstruction, diffraction pattern aren't disrupted, and they produce fine-resolution images, deal for planetary viewing. However, light rays at different wavelengths passing through glass – or water - are ***refracted, or bent, at different angles,*** resulting in false colour around bright objects.

Additional lenses and special glass minimise this effect, but add to the cost of an already more expensive design.

CASSEGRAINS use a combination of both mirrors and lenses to focus the light rays. The technique is named after the Frenchman who invented the hybrid design., and there are two main types, both derivatives, also named after the men who designed modifications to the original design :-



Schmidt-Cassegrains, have thin, aspherical corrector plates [lenses], installed at the tube's opening, which exactly match the primary concave mirror and correct for spherical aberration.

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Light travelling parallel to the corrector plate pass through it onto the primary mirror which then reflects the rays onto a secondary convex mirror mounted inside the focal point, concentric with the corrector plate.

The rays are then reflected back down the tube and through a hole in the centre of the primary mirror by a secondary mirror. Eyepieces are fitted behind this hole. A variety of diagonal eyepieces can be used to change the viewing angle, and focused by moving the primary mirror or eyepiece.

Maksutov-Cassegrains also use corrector plates to overcome spherical aberration, but Maksutov's have thick, meniscus lenses in place of the Schmidt lense. Light enters through the *concave* side of this corrector plate onto the primary mirror which, as before, returns the rays back up the tube to the secondary which, in this case, is usually a mirrored area on the *convex* side of the corrector plate. Once again, the light rays are reflected back down the tube, through the hole in the primary, and into the eyepiece.

With the Corrector plate effectively doubling as a secondary via a basic reflective surface on it's convex side, the design is easier, and less expensive to produce than Schmidt-Cassegrains. A drawback is the extra weight of the thicker corrector lense, especially on those with larger apertures.

The short tube lengths offered by Maksutov's 'folding' the light path back and forth, to get disproportionately long focal lengths make them more portable, but result in much narrow fields of view with standard eyepieces.

PART 2 - Features, pro's and con's

Most astronomical objects do not require a telescope with erecting views

With so many telescopes to choose from, choosing one can be difficult. To eliminate some options, decide what kind of observing you want to do?

Astronomical, Terrestrial or both? Using a telescope for astronomy and terrestrial use means ***compromise,*** so decide its main purpose first to make your final choice easier.

Mainly night-sky observations - 'upside-down' images are acceptable, and focusing on nearby objects doesn't apply. The most interesting night sky objects are usually very faint, so most new observers tend to view our moon and the planets which only require small primary mirrors or lenses, but, with only a little experience, star clusters, nebulae and galaxies become enticing. This means larger apertures, so don't buy until you've observed both. Find a friendly astronomer, or join a club, and keep in mind the cost, weight/portability, and whether you ive in light polluted, suburban areas.

Original Image — *Inverted image seen through a reflector* — *Mirror reversed image seen through a refractor*

Reflectors, or Newtonians - great for astronomical use. Lower cost per mm of aperture, and deep sky nebulae and faint galaxies can be viewed with reflectors having apertures between 150 and 200mm (6 to 8 inch).

Refractors - High power and contrast. Sharp, quality images of the moon and planets. Easy to operate, and virtually maintenance free. BUT, more expensive, especially the larger ones. Usually Newtonians are the best 1st telescope.

Short-tube refractors - Smaller size makes them more portable whilst still offering wider fields of view, and thus easier to find your way around night skies with more stars visible in the eyepiece.

Long-tube refractors - Best for terrestrial viewing, but short refractors with 70 - 100mm apertures, and focal lengths between 400 & 700mm have wider fields of view for land and night viewing, and, by gathering more light, give better resolution. More important than magnification.

45 degree erect image diagonal is requred for daytime nature study

90 degree diagonal is preferred for nighttime astronomical observations

Heat haze, caused by air currents in the viewing plane corrupt images by making them shimmer under high magnification on hot and/or windy days. You can't look 'over' a Newtonian to see a target, rendering them unsuitable for terrestrial use, so the best dual purpose choice is a refractor – the larger the aperture, the higher magnification needed for the same resolution. Refractors fitted with a 45 degree erect image eyepiece keep images the 'right side up' for daytime viewing, and a 90 degree star diagonal makes for a more comfortable nighttime observing.

Location Longer tubes improve contrast in light polluted areas, but reduce the field of view, so low magnification is best when using larger aperture scopes in urban areas. All telescopes perform far better in darker sky areas.

Other features to include in your choice of telescope.

Finderscopes - are small auxiliary telescopes, fitted to the tube and aligned with its axis. They use low magnification to give a wide field of view.

Most have crosshairs – some illuminated - to help centre and find objects.

NB. Most give an upside down or left-right reverse image.

Focusers – are assemblies adjusted - usually by rack-and-pinion - to bring the image into sharp focus by moving the eyepiece in and out.

Ensure the movement is smooth, with little effort needed for adjustment, to prevent vibrations which make images dither around in the eyepiece.

Standard focusers come in two sizes for 1.25 inch, or 2 inch barrel diameters.

Lense Coatings - Thin layers of optical materiel on lenses and mirrors, enhance light transmission, protect surfaces and suppress flare and color aberrations. *NB. If you can see your reflection in any coated lense, its cheap. Don't buy it*

Telescope specifications

Aperture - The aperture of a telescope is the diameter of it's objective lense, or primary mirror, specified in inches or millimeters. The larger the aperture, the more light it collects, the brighter (and better) the image. In general, greater detail and image clarity are observed with each increase in aperture.

Focal Length – The distance - in mm or inches - from the lense (or primary mirror) to its focal point. The longer the focal length the more magnification produced with any given eyepiece. But, at a much reduced the field of view.

Focal Ratio – is the 'scope's focal length divided by it's aperture - in mm or inches. EG. A telescope with a focal length of 1000mm and a 200mm aperture, has a focal ratio of five [1000 / 200 = 5], or f/5. 'Scopes of f/4 to f/6 are called "fast" systems with lower magnifying power and wider fields of view than slow f/8 to f/15 systems.

Magnification – Telescopes are NOT rated by their magnifying power, only by their aperture, or light gathering capability. The aperture of a telescope is far more important than the magnifying power, because it determines the telescopes ability to resolve small or distant objects, and usable power is limited to approx 2 x diameter in mm.

Joe Mather 22 Mar 2011