Bear Valley Springs Astronomy Club

Types of Telescopes

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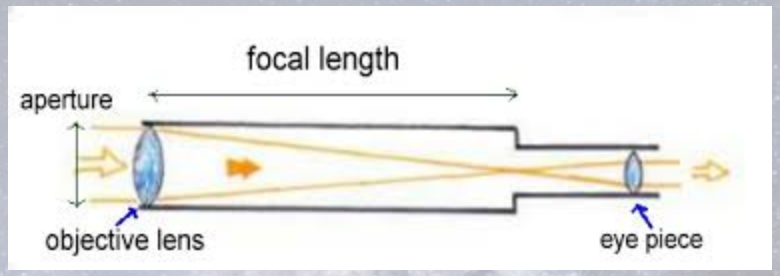
Three Main Types of Optical Telescopes:

-Refractor - A refracting or refractor telescope is a type of telescope that uses a len(s) as its objective to form an image

-Reflector -A reflecting telescope or reflector is a telescope which uses a single or combination of curved mirrors that reflect light and form an image

-Catadioptric - A catadioptric optical system is one where refraction and reflection are combined in an optical system, usually via lenses (dioptrics) and curved mirrors (catoptrics)

The Refractor Telescope



Types of Refractors

Simple Objective – Galilean, Keplerian (1609)

Blurry, distorted images with chromatic and spherical aberration. Narrow field-of-view, limited magnification. Very long focal length to be useable

Achromatic – Two-part Objective, crown & flint glass (1733)

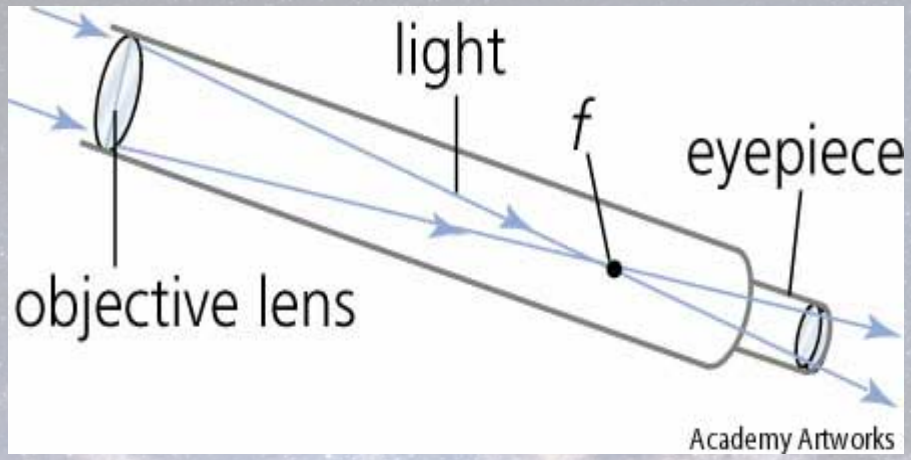
Sharp images in single colors, chromatic and spherical aberrations much reduced. Slightly shorter focal lengths useable

Modern doublet refractors may use ED (extra-low dispersion) glass, which makes for very good corrections of aberrations

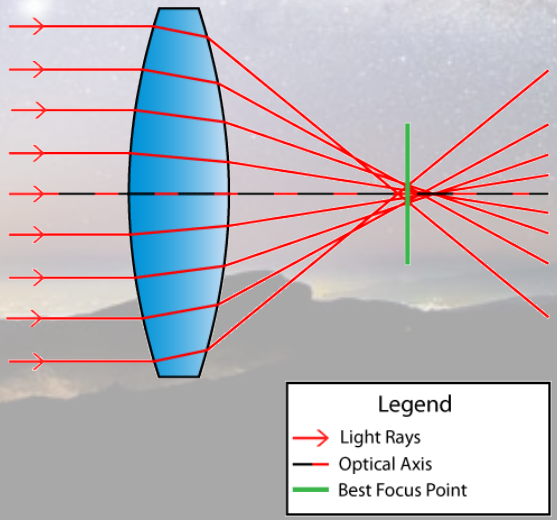
Apochromatic -Multi-elements (3 or more) of low-dispersion glass

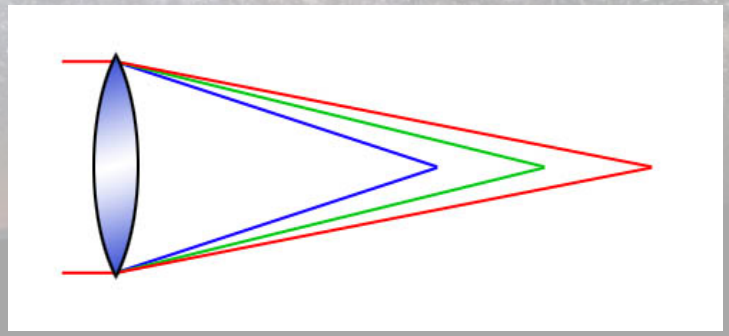
Very crisp image virtually free of aberrations. Short focal lengths usable. Expensive.

Simple Refractor

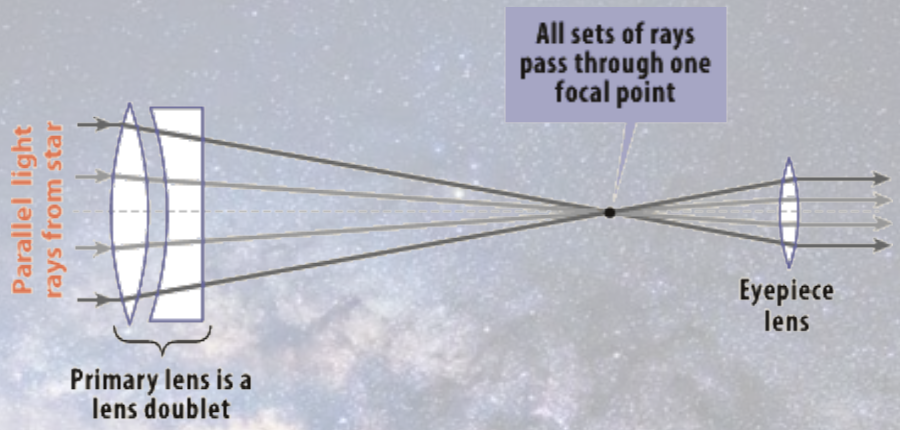


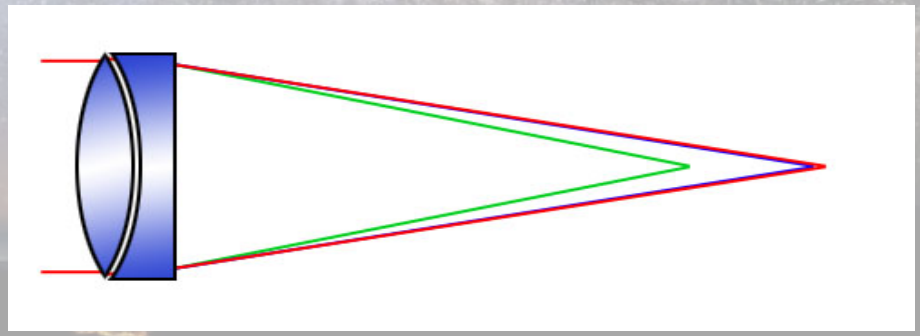
Lens with
Spherical Aberration



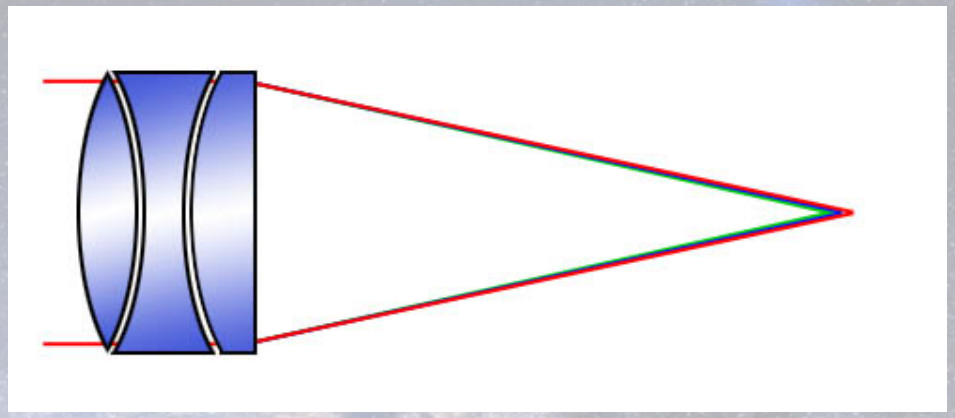


Achromatic Refractor





Apochromatic Refractor (APO)



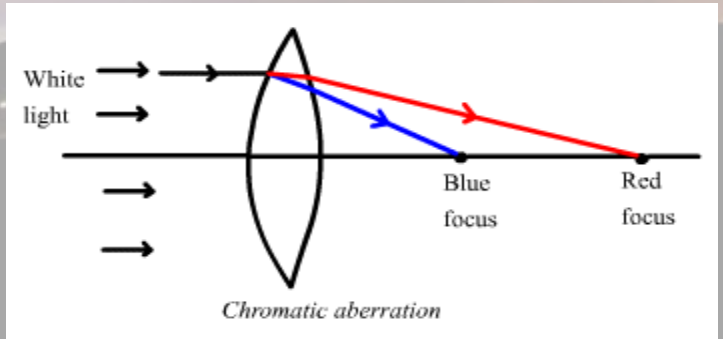
Advantages and Disadvantages of Refracting Telescopes:

Advantages:

1. Superior resolving power per inch of aperture
2. Superior performance in inferior conditions - image steadier
3. No reflections or interruption of light path
4. Near permanent optical alignment - minimum maintanance
5. Long focal ratios can mean use of longer focus, simpler, eyepieces (non-APO)
6. APO Refractors can have shorter focal lengths, so easier to handle and give wider field-of-view

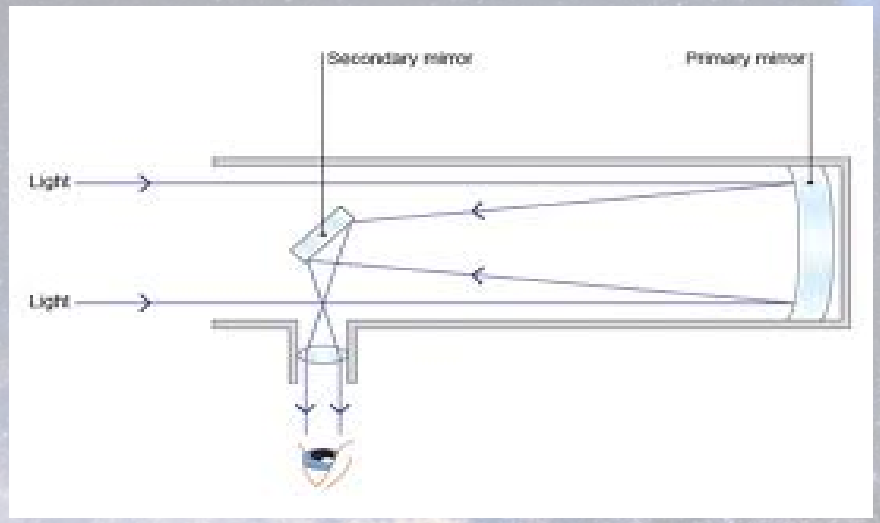
Disadvantages:

1. Very high initial cost relative to reflecting optical system (glass must be excellent), especially APOs.
2. A certain amount of secondary spectrum (chromatic aberration) unavoidable.The colors cannot focus at one point (might be unnoticeable in APOs).
3. Long focal ratios can mean that the instrument is cumbersome
4. Relatively small field-of-view (except some APOs)



Chromatic aberration

The Reflector Telescope



Types of Reflectors

Gregorian Reflector (1663)

Concave secondary mirror that reflects the image back through a hole in the primary mirror. Examples: Vatican Advanced Tech Telescope, Magellan telescopes, the Large Binocular Telescope, Giant Magellan Telescope

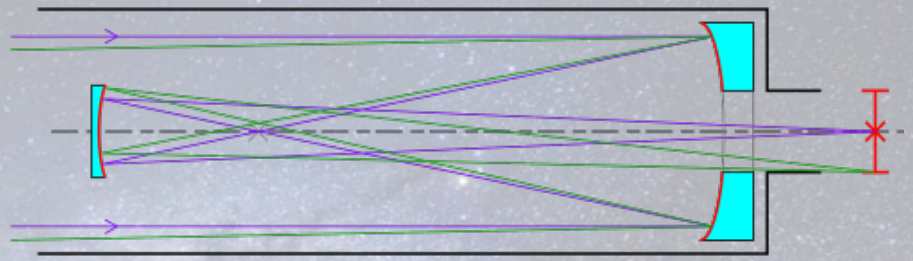
Newtonian Reflector (1668)

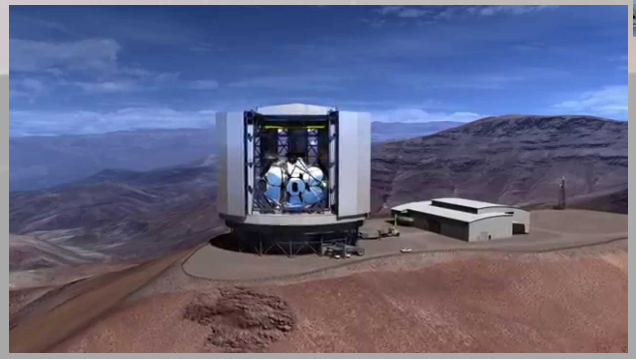
Paraboloid primary and flat secondary. Most ATM and Dobsonians. Example: Hooker Telescope

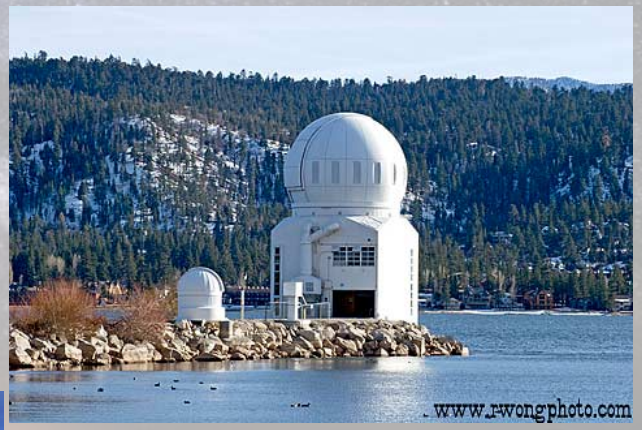
Cassegrain Reflector (1672)

Parabolic primary and hyperbolic secondary (many 1-2m class telescopes). Variants: Ritchey-Chretien (Hubble, Keck, VLT) and Dall Kirkham.

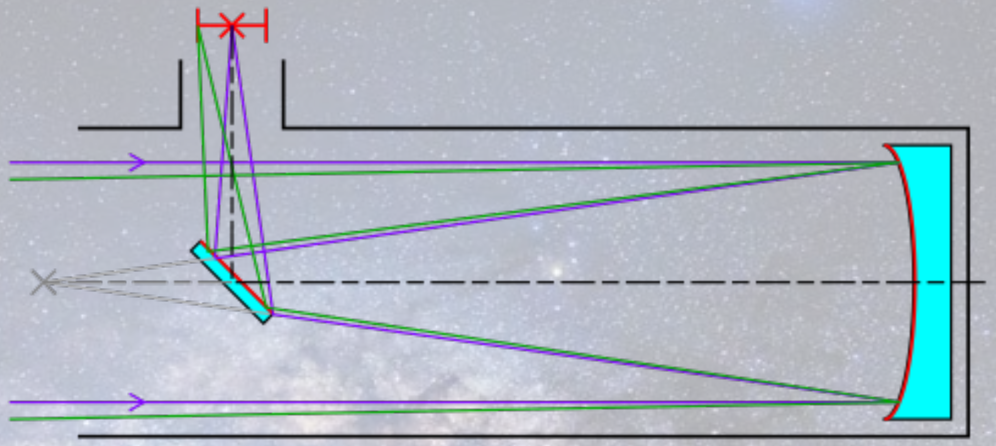
Gregorian Reflector



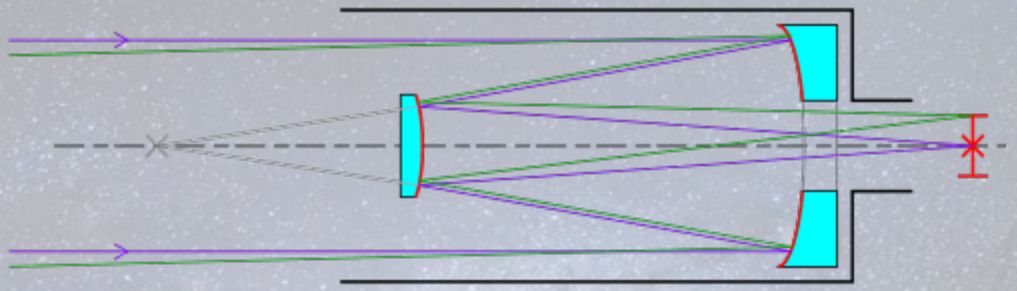


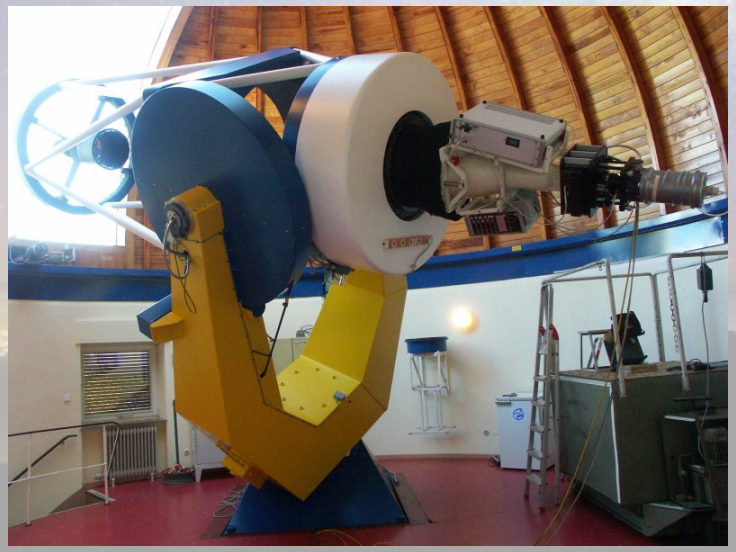


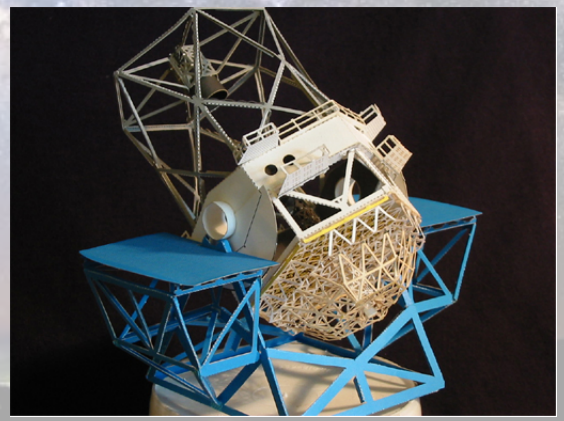
Newtonian Reflector

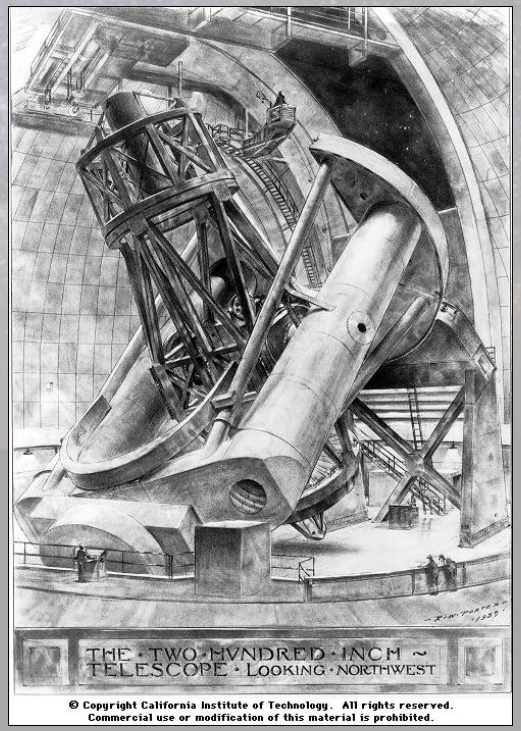


Cassegrain Reflector









Advantages and Disadvantages of Reflecting Telescopes:

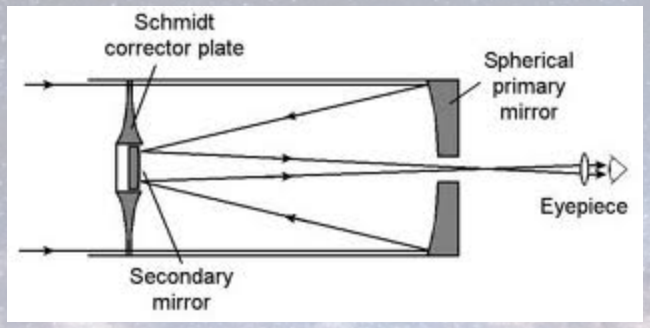
Advantages:

1. Allows all colors to come to focus at one point
2. Mirrors can be very large.
3. Glass problems do not affect light entering in.
4. Much less expensive for larger apertures (light-gathering ability)
5. Able to reach ambient temperature quickly due to open tube
6. Fast optics give wide-field views

Disadvantages:

1. Open tube – collects dust and dirt. Will need periodic cleaning
2. Maintenance. Can need recollimation periodically
3. Long tubes can mean that the instrument is cumbersome
4. Optical quality sometimes disappointing, as fast optical systems can have aberrations like coma and spherical aberration that make higher magnification difficult

The Catadioptric Telescope



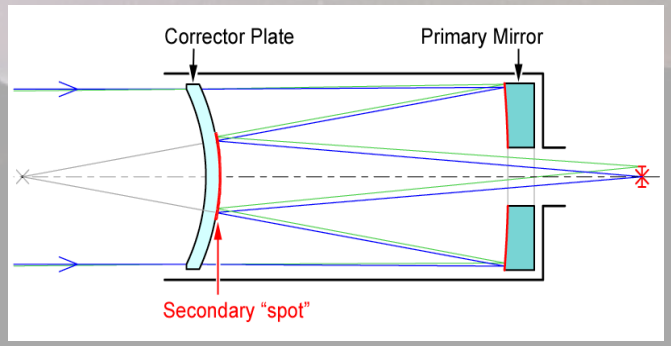
Types of Catadioptric Telescopes

Schmidt-Cassegrain (1940)

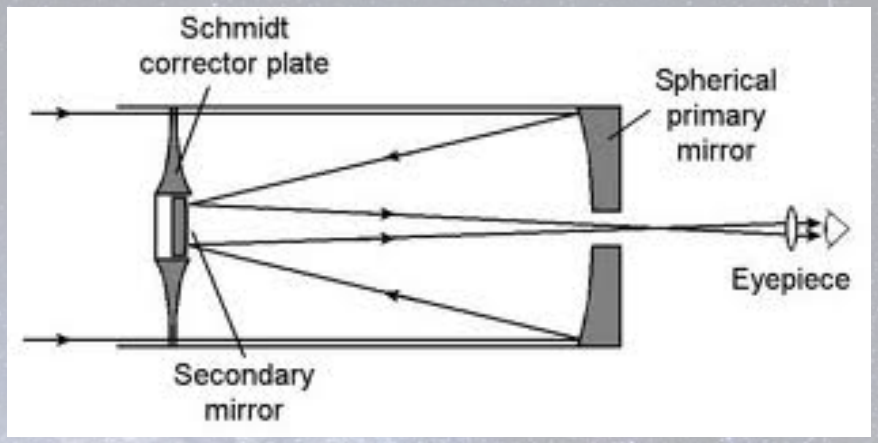
Spherical primary and secondary and a front corrector plate. Compact and easy to manufacture. A variant is the Meade ACF design which uses a hyperbolic secondary instead of a spherical one.

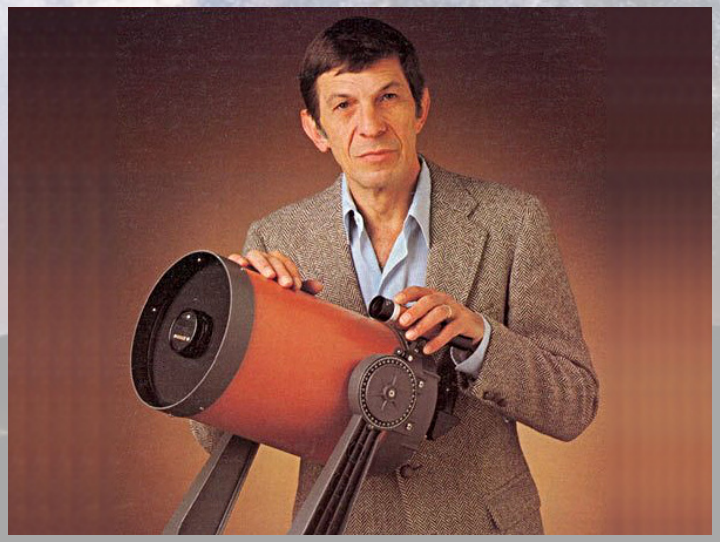
Maksutov-Cassegrain (1941)

All spherical surfaces with a “spot” secondary. Compact and rugged with fixed collimation, but usually smaller aperture due to corrector plate being large & heavy and cooling slowly.

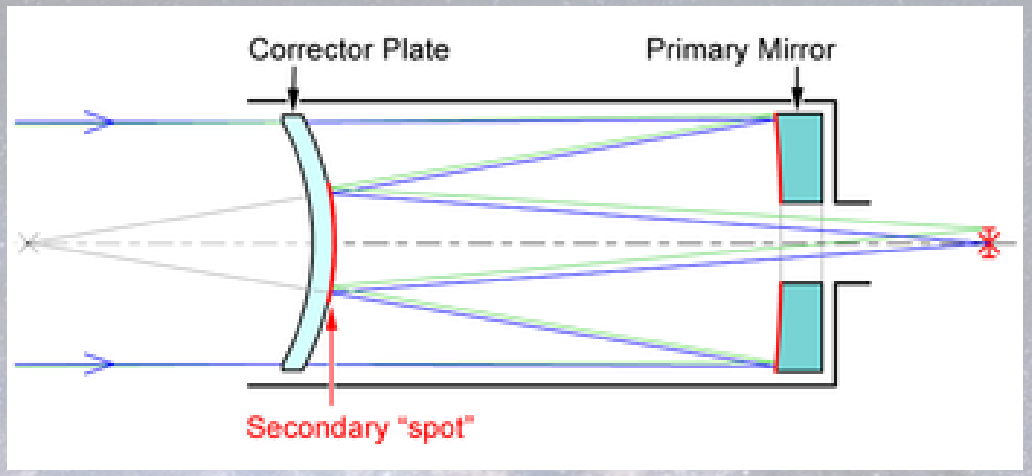


Schmidt-Cassegrain





Maksutov-Cassegrain



Advantages and Disadvantages of Catadioptric Telescopes:

Advantages:

1. Catadioptric telescopes use a folded-path optical system and thus can be shorter than their focal length would imply.
2. They are lighter and more compact when compared to telescopes of the same aperture, as is the mount that holds them, so they are easier to transport.
3. Their ability to use mirrors with purely spherical figures and easily reproduced refractive elements, usually called corrector lenses, results in lower manufacturing costs.

Disadvantages:

1. Catadioptric telescopes become heavier rather quickly as they increase in aperture.
2. They may require more frequent optical alignment when compared to refractors.
3. A catadioptric telescope's moving parts are more complex than those found in refractor or reflector telescope.
4. Catadioptric telescopes have an inherent optical performance limitation based on the central obscuration of their aperture caused by their own secondary mirror. However, classical Cassegrain and Newtonian reflecting telescopes share this problem. The "limitation" is very subtle, so most amateur astronomers do not even notice or care about this detail.
5. More optical surfaces than most reflectors and refractors (light loss).
6. Long focal length (f/10 or f/11).
7. Slow to reach ambient temperature when observing. (Can install fan)

So What Telescope Do I Choose??:

Planetary and Solar Observing:

Optimum: A High-quality Refractor telescope is the #1 choice due it's resolving power
Caveat: Expensive

Deep-Sky Observing:

Optimum: A large Reflector is the #1 choice due to it's light-gathering ability and low cost
Caveat: Large and Bulky

All-around Observing:

Optimum: A Catadioptric is the #1 choice due to combination of both refractor and reflector characteristics
Caveat: More expensive than Reflector but less cumbersome, less expensive than Refractor but more light-gathering ability for the cost

ADVICE: GO TO STAR PARTIES AND LOOK THROUGH AS MANY TELESCOPES AS YOU CAN BEFORE YOU DECIDE