Telescope Types and Designs

There are three basic types of optical telescopes – Refractor, Newtonian reflector and Catadioptric. All of these telescopes are designed to collect light and bring it to a focus point so that it can be magnified by an eyepiece, however each design does it in a different manner. Each of the designs has the potential to perform very well, and all have their own virtues, as well as faults.

We will now briefly discuss the most popular types of telescopes and describe their advantages and disadvantages.

Schematic view of a Refracting Telescope

Refractor

The Refractor, also known as the dioptrics, is a telescope that uses lenses to refract, (bend), the light that it collects. This refraction causes parallel light rays that converge at a focal point at the opposite end, where they can be magnified by an eyepiece. The large lens at the front is called the objective lens. The objective lens usually comprises of two or more individual lenses that are bonded and or arranged together to make up what is called the objective lens cell. The glass material used can also vary which will help in the overall performance of the objective lens.

Advantages

- Little or no maintenance and is easy to use.
- Reliable due to the simplicity of design.
- Excellent for lunar, planetary or binary star viewing.
- Good for terrestrial viewing.
- High contrast images due to its clear aperture (no central obstruction).
- Good color correction in achromatic designs and excellent in apochromatic, flourite and ED designs.
- Sealed optical tube reduces image degrading air currents and protects the optics.
- Objective lens is usually permanently mounted and aligned.

Disadvantages

- Usually more expensive per inch of aperture than Newtonians or Catadioptrics.
- Heavier, longer and bulkier than equivalent aperture Newtonians or Catadioptrics.

- The cost and bulk factors usually limit the maximum size to smaller apertures.
- Less suited for observation of deep sky objects such as distant galaxies and nebulae because of practical aperture limitations.
- Some color aberration in achromatic designs (doublet).
- Poor reputation due to low quality imported toy telescopes; a reputation unjustified when dealing with a quality refractor from a reputable manufacturer.

Yerkes 102cm Refractor

Schematic view of a Newtonian / Reflecting Telescope

Newtonian Reflector

The Newtonian Reflector, also known as catoptrics, is a telescope which uses a spherical or concave parabolic primary mirror to collect, reflect and focus the light onto a flat secondary mirror (diagonal). This secondary mirror in turn reflects the light out of an opening in the side of the tube and into an eyepiece for focus and magnification.

Advantages

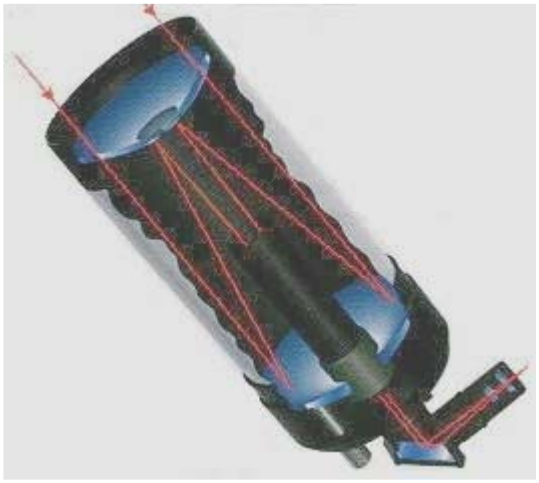
- Lowest cost per inch of aperture compared to refractors and Catadioptrics since mirrors can be produced at less cost than lenses in medium to large apertures.
- Reasonably compact and portable up to focal lengths of 1000mm.
- Excellent for faint deep sky objects such as remote galaxies, nebulae and star clusters due to the generally fast focal ratios (f/4 to f/8).
- Reasonably good for lunar and planetary work.
- Good for deep sky astrophotography (but not as convenient and more difficult to use than Catadioptrics).

Mt Palomar 200" Reflecting Telescope

- Low in optical aberrations and deliver very bright images.

Disadvantages

- Requires regular alignment (collimation) of optics in order to perform at its best. Badly aligned optics can make the image quality suffer quite dramatically.
- Primary mirror may require re-coating (usually after years of service).
- The open nature of the tube assembly could mean more complicated cleaning of mirror surfaces when compared to telescopes of other designs.
- Generally not suited for terrestrial applications.
- Slight light loss due to secondary (diagonal) obstruction when compared with refractors.



Schematic View of a Maksutov-Cassegrain

Catadioptrics

Catadioptrics are telescopes that use a combination of mirrors and lenses to fold the light path and direct it for focus and magnification through a hole in the primary mirror. There are two popular designs, the Maksutov-Cassegrain and Schmidt-Cassegrain. Both designs have similar advantages and disadvantages.

In Maksutov designs the light enters a thick meniscus correcting lens with a strong curvature. The light then strikes the primary mirror and is reflected back up to the secondary mirror that reflects the light out an opening in the rear of the instrument. The secondary mirror is usually an aluminized spot on the back of the meniscus corrector. The Maksutov secondary mirror is usually smaller than the Schmidt's thus giving the Maksutov better resolution for planetary observing. The Maksutov is usually heavier than the Schmidt and the thicker correcting lens takes longer to reach thermal stability.

In Schmidt designs the light enters a thin aspheric Schmidt correcting lens. The light then strikes the primary mirror and is reflected back up to the secondary mirror that reflects the light out an opening in the rear of the instrument. Schmidt's usually have shorter focal lengths thus making them more suitable for fainter deep sky objects. The thinner corrector

Schematic view of a Schmidt-Cassegrain

Mt Palomar 60" Schmidt Focus Telescope

plate means the Schmidt is faster to reach thermal stability.

Advantages

- Best all-around, all-purpose telescope design. Combines the optical advantages of both lenses and mirrors while cancelling their disadvantages.
- Excellent optics with razor sharp images over a wide field.
- Excellent for deep sky observing or astrophotography with fast films or CCD's.
- Very good for lunar, planetary and binary star observing or photography.
- Excellent for terrestrial viewing or photography.
- Focal ratio generally around f/10. Useful for all types of photography. Avoid faster f/ratio telescopes (they yield lower contrast and increase aberrations). For faster astrophotography, use a Reducer/Corrector lens.
- Closed tube design reduces image degrading air currents.
- Most are extremely compact and portable.
- Easy to use.
- Durable and virtually maintenance free.
- Large apertures at reasonable prices and usually less expensive than equivalent aperture refractors.
- Most versatile type of telescope.
- More accessories available than with other types of telescopes.
- Best near focus capability of any type telescope

Disadvantages

- More expensive than Newtonians of equal aperture.
- It is not what people expect a telescope to look like.
- Slight light loss due to secondary mirror obstruction compared to refractors.
- May suffer from image shift when focusing due to focus design moving the entire primary mirror.
- May have a narrower field of view (Maksutov's) when compared to similar aperture Newtonians or Refractors due to

longer focal lengths.

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