

Light

Geometrical Optics

Newton treated light as corpuscular – a beam of particles (photons)

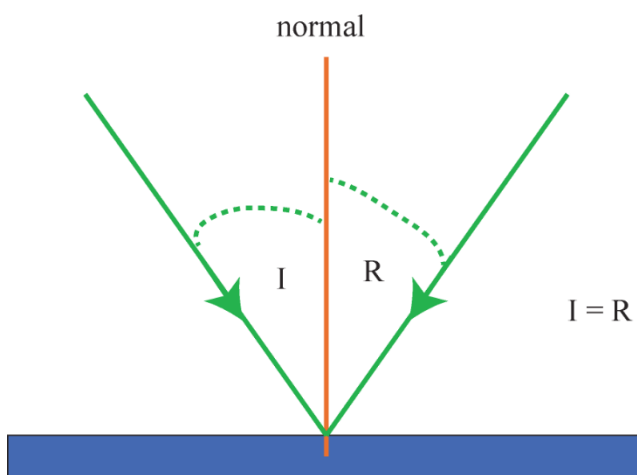
Huygens later showed light could be treated as waves – gave same results but can be more useful (interference effects)

Christiaan Huygens(1629 – 1695) was a Dutch [physicist](#), [mathematician](#), [astronomer](#) and [inventor](#), who is widely regarded as one of the greatest scientists of all time and a major figure in the [scientific revolution](#). In physics, Huygens made groundbreaking contributions in [optics](#) and [mechanics](#), while as an astronomer he is chiefly known for his studies of the [rings of Saturn](#) and the discovery of its moon [Titan](#). As an inventor, he improved the design of the telescope with the invention of the [Huygenian eyepiece](#). His most famous invention, however, was the invention of the [pendulum clock](#) in 1656, which was a breakthrough in timekeeping and became the most accurate timekeeper for almost 300 years. Because he was the first to use mathematical formulae to describe the laws of physics, Huygens has been called the first [theoretical physicist](#) and the founder of [mathematical physics](#).



Credit: Wikipedia, Painting by Caspar Netscher, Museum Boerhaave, Leiden

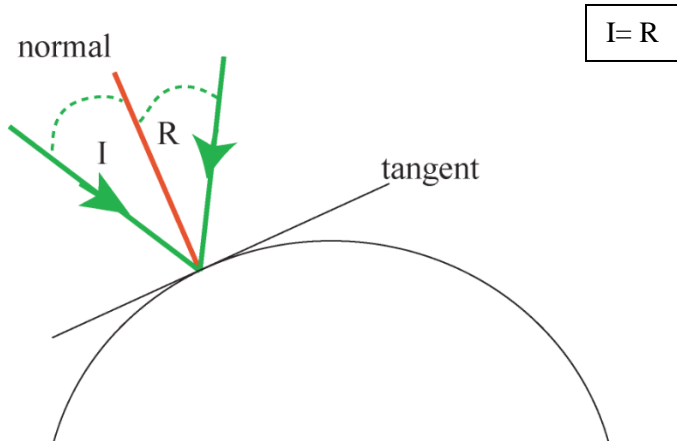
Laws of Reflection



A ray of light is reflected such that the angle of reflection = angle of incidence

Mirror surface

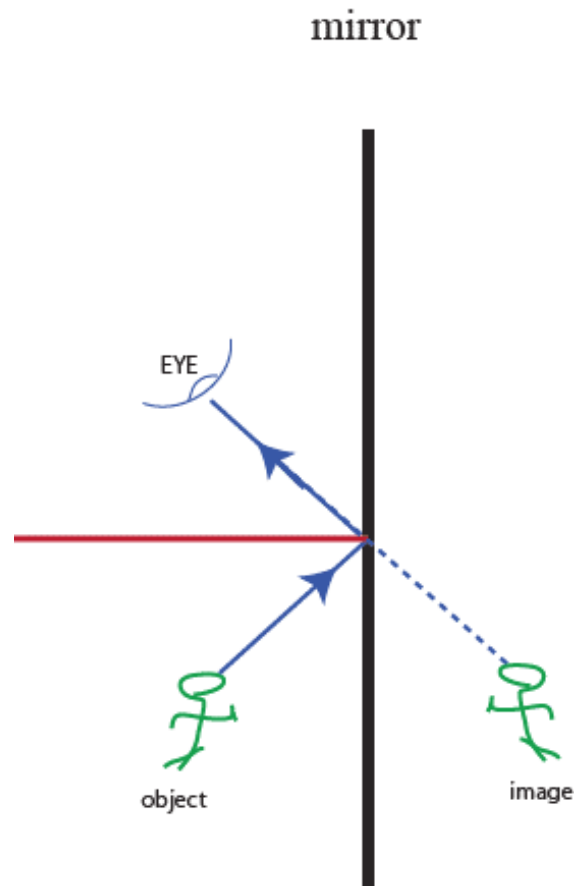
Curved surface



Applications

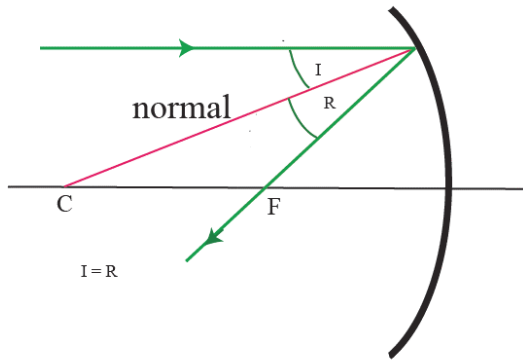
Plane mirror

Image is behind mirror
(virtual image)

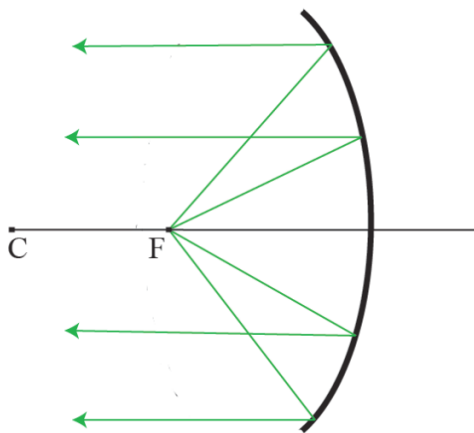


Spherical Mirror

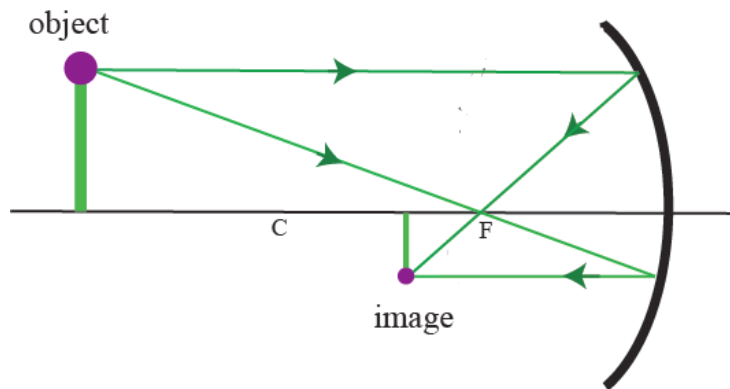
Concave



Parallel rays ALL go through the focus F
Rays from center C reflected back to C

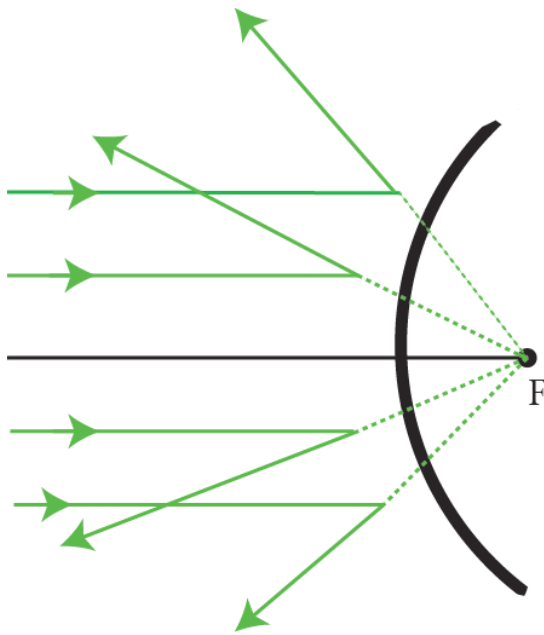


Source at focus F sends out a parallel beam from mirror

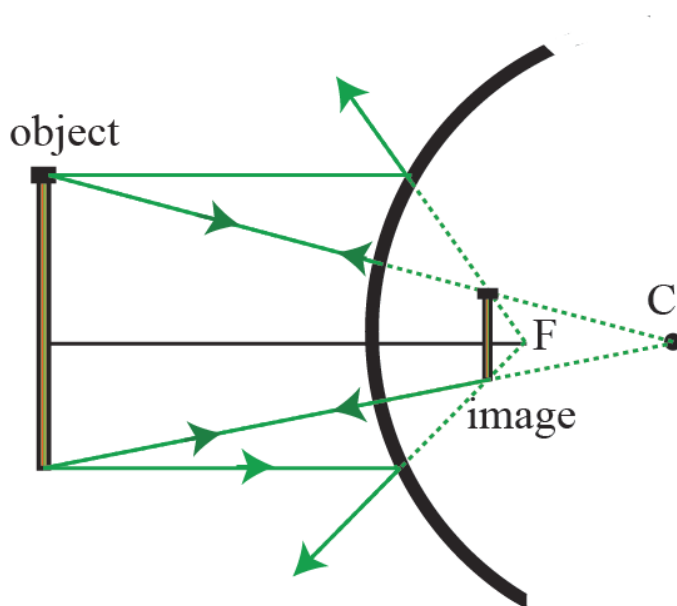


Object beyond C
Image inverted and reduced in size

Convex Mirror



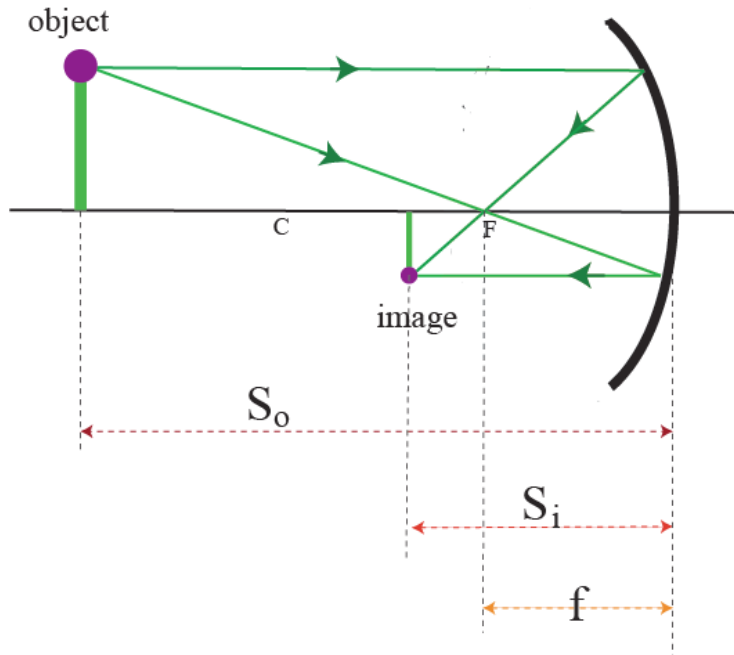
A parallel beam incident on convex mirror is reflected radially as if from a fixed point source at the focus point F.



Light from an object is emitted form a VIRTUAL image behind the mirror.

Image is upright and reduced in size.

The Mirror Formula (Concave)



$$\frac{1}{f} = \frac{1}{S_o} + \frac{1}{S_i}$$

$$\text{Magnification } M = - \frac{S_i}{S_o}$$

Example:

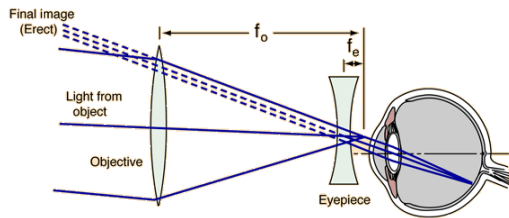
$$S_o = 30 \text{ cm}, \quad f = 10 \text{ cm}$$

$$\frac{1}{S_i} = \frac{1}{f} - \frac{1}{S_o} = \frac{1}{10} - \frac{1}{30} = \frac{2}{30} \quad \text{or } S_i = 15 \text{ cm}$$

$$M = - \frac{S_i}{S_o} = - 0.5$$

Telescopes

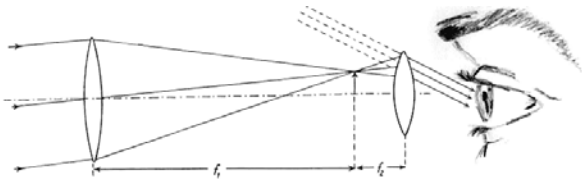
Galilean telescope



Galilean telescope uses a convex lens to focus parallel beam at a point, BUT intercept with concave lens just in front of image and this renders light parallel as it enters eye. Credit: Hyperphysics

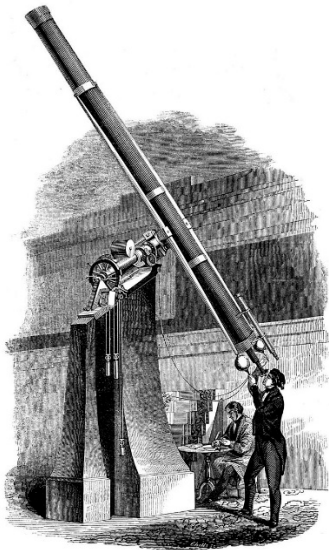
<http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/teles.html>

Keplerian telescope



Uses convex lens for eyepiece. Needs to be very long. Image inverted. "Wider field of view & this Less eye strain"

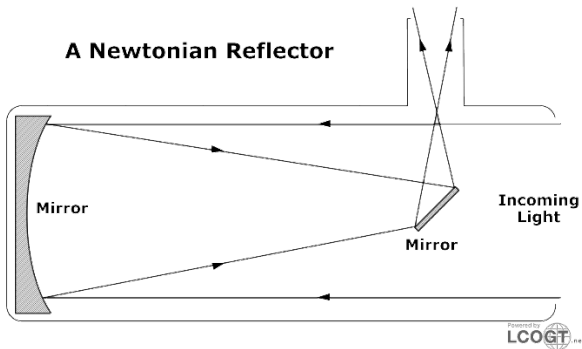
https://en.wikipedia.org/wiki/Refracting_telescope



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<https://commons.wikimedia.org/w/index.php?curid=20023550>

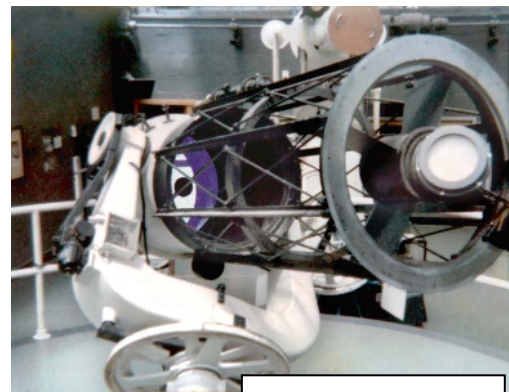
Reflecting telescopes



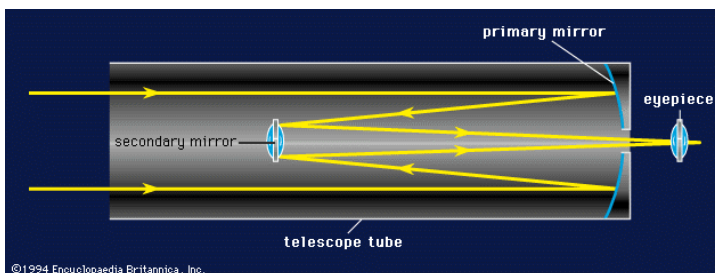
Mirrors advantage over Galilean refracting telescope. No chromatic aberration

Use concave mirror to focus parallel beam (from far object) at focus, but intercept with mirror that's end to eyepiece. Light weak. Need LARGE area.

https://en.wikipedia.org/wiki/Reflecting_telescope



Franklin Institute



Cassegrain telescope sacrifice small area in center of concave mirror to exit image.

http://abyss.uoregon.edu/~js/glossary/reflecting_telescope.html

UF partner in Gran Telescopi Canaria

The GTC Project is a partnership formed by several institutions from [Spain](#) and [Mexico](#), the [University of Florida](#), the [National Autonomous University of Mexico](#). It is the [world's largest single-aperture optical telescope](#).^[5] The division of telescope time reflects the structure of its financing: 90% Spain, 5% Mexico and 5% the University of Florida. (https://en.wikipedia.org/wiki/Gran_Telescopio_Canarias)

One of the most advanced optical and infra-red telescopes in the world. Its primary mirror consists of 36 individual hexagonal segments that together act as a single mirror. The light collecting mirror surface area of GTC is equivalent to that of a telescope with a 10.4m diameter single monolithic mirror. Thanks to its huge collecting area and advanced engineering the GTC classes amongst the best performing telescopes for astronomical research. (<http://www.gtc.iac.es/gtc/gtc.php>)

