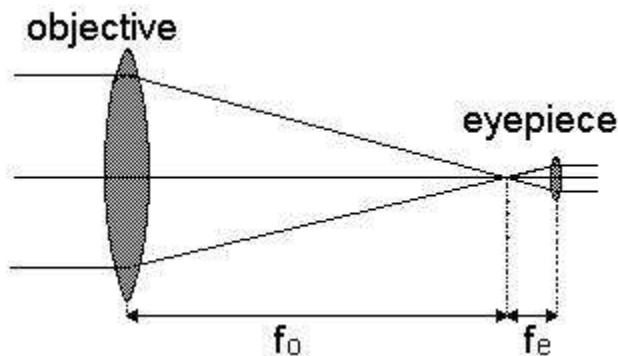


Summary Notes - Topic 11: Exploring the Solar System Part 2



11.14–11.25 Telescopes & Observations

- **Limitations of the Human Eye** – Small aperture, poor low-light sensitivity.
- **Telescope Terms:**
 - **Objective element** - collects as much light as possible and focuses the light to a small bright image.
 - The aperture is the diameter of the objective lens or mirror. The bigger the aperture:
 - The more light, brighter image
 - The shaper the image
 - **Light Grasp** - is a measure of a telescope's ability to capture light; it depends on its cross-sectional area. (Square of the diameter).
 - **Resolution** - how a telescope will show the detail of an object being observed. Resolution is dependent on:
 - Aperture of the objective element
 - Wavelength of light – the longer the wavelength the poorer the resolution
- **Magnification**

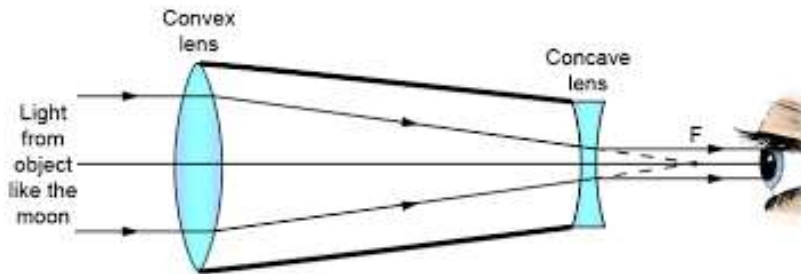


$$\text{Magnification} = \frac{f_o}{f_e}$$

- **Field of view** - Circle of the sky that is visible through the eyepiece. Measured in degrees or minutes of arc. The greater the magnification the smaller the FOV

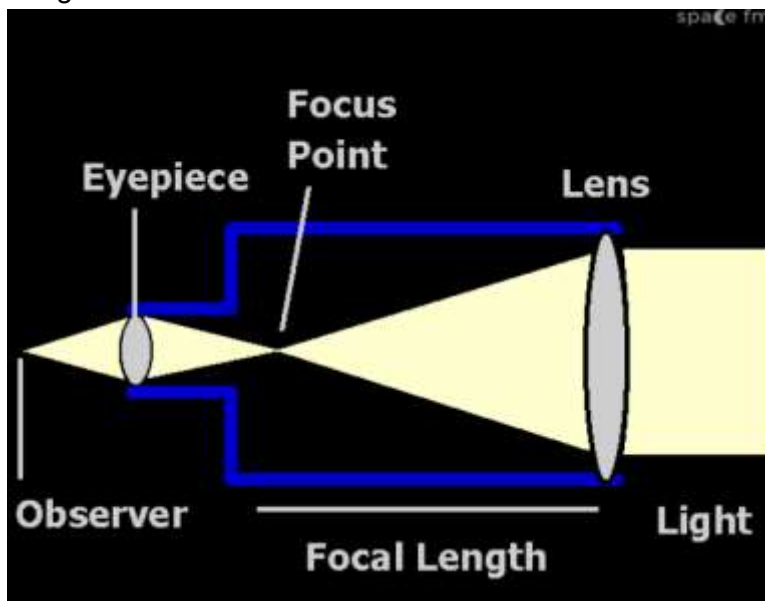


- **Refracting telescopes** - A convex lens is used at the end of a tube to bring an image into focus at a point. Another lens called an eyepiece is used at the opposite end of the tube to magnify the image. The lens is typically made of glass coated in a film to allow less light to be reflected and more to pass through the lens.
 - **Galilean** - uses a concave lens as the eyepiece and is typically fixed focus and has a limited field of view. Used by Galileo to make observations of the night sky to develop the heliocentric model of the solar system.

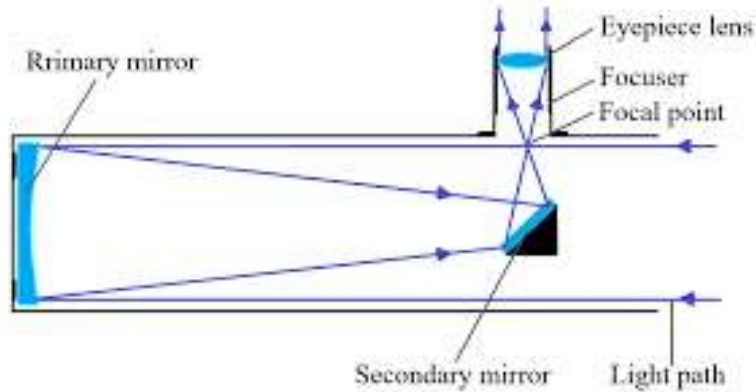


- **Keplerian** - uses a convex lens and is larger or heavier as they are focusable, but images are inverted.

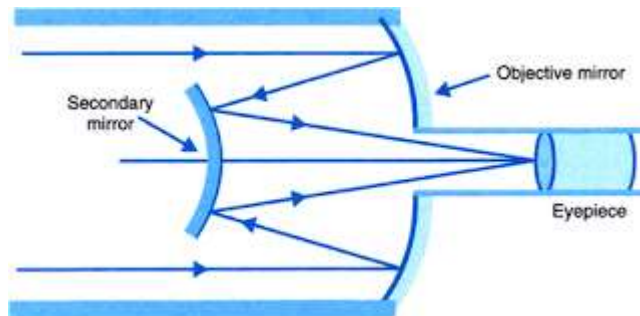
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- **Reflecting Telescopes** - A reflector collects light at one end of a tube and reflects it off a concave mirror. A reflector's mirror is usually made of glass with an aluminium coating.
 - **Newtonian** - It is brought to a focus by a secondary mirror further up the tube at a 45-degree angle which is then magnified using an eyepiece.



- **Cassegrain** - This reflects light from its concave lens to a secondary mirror. This mirror is facing the primary mirror and reflects the light back down towards the primary but focuses through a small hole behind the primary.



- **Inversion** - Depending on the type of telescope you use, you will notice that images may be upside down or back to front.

Advantages of reflecting telescopes over refracting telescopes


- **Chromatic aberration** - occurs when a lens fails to focus light rays' colours to the same focal point. The effect is that images may appear skewed or stretched.
- **Large apertures** - A lens will be held in place at the edge of a tube and if large enough will suffer from sagging and so distorts its image. There is a size limit to this. Mirrors are cheaper.
- **Focal lengths & Multiple Mirrors** - More wavelengths are absorbed by passing through an entire lens in a refractor, whereas reflecting reflect the light back from their mirror. All parts of a lens need to be manufactured and maintained to be free of impurities whereas only one side needs to be kept pristine in a mirror. A secondary mirror is usually added and while this

will decrease the amount of light entering the scope, it can also be used to add a sensor or for digital photography. Its main advantage is that the focal length can be increased while retaining a practical shorter tube than would be needed for a refractor.

How to Choose a Telescope

Deciding between a reflecting and refracting telescope.

REFLECTOR	REFRACTOR
<ul style="list-style-type: none">• Open system requires some maintenance• Images upside down• No chromatic aberration• Has spherical aberration• Less expensive for large aperture	<ul style="list-style-type: none">• Beginner friendly closed system• Images right side up• Some color fringing• Easier to see perfect circles• Long, but typically portable and easy to store



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11.26–11.30 Space Exploration

- Space Probes - Space probes have several advantages over manned spaceflight. They can go further away from Earth and can travel for longer periods. They do not need extra room for life support.
- **Types of Space Probes:**
 - **Fly-by** – Briefly passes a planet Advantages - An array of sensors can measure many features of the relevant bodies and send images of distant bodies in detail never seen before. Disadvantages Flybys happen at incredible speeds, and not all parts of the observed bodies can be monitored. Once is flybys it does not return to its target. More detailed analysis of object features cannot be gathered
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took measurements of water vapour and to listen and relay Philae's communications. Philae was designed to soft land, using harpoons to attach to the surface. It was designed to analyse the surface composition of the comet including drilling into the comet. It managed to take some analysis of water-rich surface chemicals and some imagery however the lander lost power as its harpoons failed to attach to the surface, it ended up at an angle in a crack below a cliff. It was soon after unable to communicate with Rosetta and lost power due to not receiving enough sunlight.

- **Manned missions –**

- **Benefits** - Humans can cope with difficult conditions and carry out movements that no robot would be capable of. A human does not need programming and can be flexible and intelligent enough to carry out different tasks. Humans can adapt to problems and opportunities.
 - **Limitations** - Resources such as air, water and food are needed for astronauts to survive. If an unmanned probe is destroyed, then a space organisation has lost money from equipment and expertise but if a manned spacecraft is destroyed then human lives have been lost. It takes time and money to train astronauts. When astronauts are in space for a long time they suffer from muscle fatigue and deterioration. They also can suffer from mineral problems in their bodies due to the lack of gravity there. Astronauts exercise in space to prevent this happening.
- **Escape Velocity** – The speed needed to leave Earth's gravity (about 11.2 km/s).
 - **Apollo Program** – Six missions landed on the Moon between 1969 and 1972. Apollo 11 was the first to land on the Moon. Neil Armstrong and Buzz Aldrin were the first to explore the surface while Michael Collins orbited above them in a command module. The astronauts deployed Apollo Lunar Surface Experiments Package (ALSEPS). These experiments included mirrors left there so we can measure the distance to the Moon by laser, seismographs to measure moonquakes and sensors to measure solar radiation. Retroreflectors left on the Moon have told us that the Moon is moving away from Earth at a rate of 3.8 cm a year.