Astronomy

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A level 1 course
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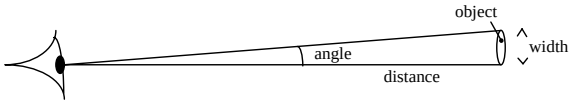
Prologue

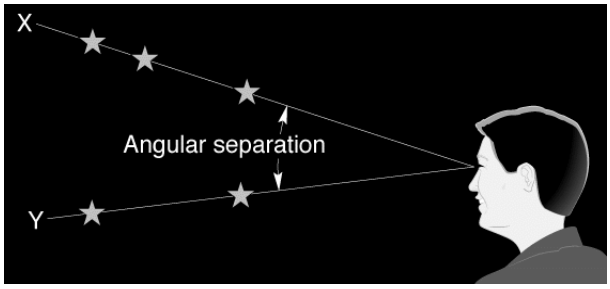
- This opening section covers:
  - seeing and angular measurements
  - an overview from planets to galaxies
  - the rôle of telescopes
  - distances in astronomy
  - reflections

On Vision



- Small angles measure the ratio of *width/distance*
- The moon subtends an angle of about 0.5°
  - the moon is 0.27 times earth's diameter and at an average distance of 384000 km
- The sun is 400 × the moon's diameter and 390 × as far away. It, too, subtends an angle of about 0.5°

Angular Measurement



On Angles

- Angles in astronomy are commonly measured in **degrees**, **minutes** and **seconds** of arc
  - there are 60 arc minutes in a degree
  - there are 60 arc seconds in an arc minute
  - e.g. 30° 15′ 4.3" . Notice the symbols for arc minutes and arc seconds
- Many objects make such a small angle of view that they are measured only in minutes, or sometimes seconds, of arc

Example on Angles

- Given: Saturn's diameter is 120,000 km
  Saturn's distance is 1500 million km
  - ✪ what angle does the disk of Saturn subtend?
- Calculate: 1. work out the ratio *width/distance*
  2. use *arctan* or tan^{-1} calculator button
  3. answer is 0.00458°
  (×60) ≡ 0.275' (arc minutes)
  (×60) ≡ 16.5" (arc seconds)

The Eye

- If your eye's lens is perfect, the size of the light receptor cells at the back of your eye sets the limit on how well you can distinguish close together objects

- The sharpest eyes can distinguish objects 0.01° apart, about 0.5' arc
  - ✪ you could just tell whether someone is holding up 1 or 2 fingers at 100 m. You can't see Saturn's rings unaided

The 8 Planets & More

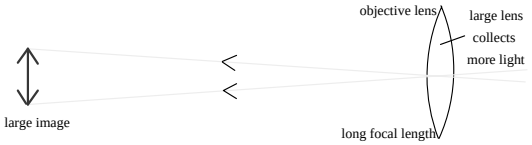
- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus - barely seen with naked eye
- Neptune - not seen with naked eye

Asteroids

Pluto & more

Cue slides

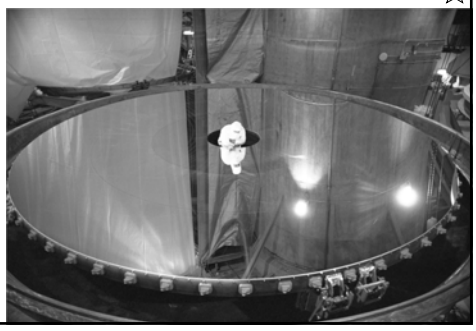
Purpose of a Telescope



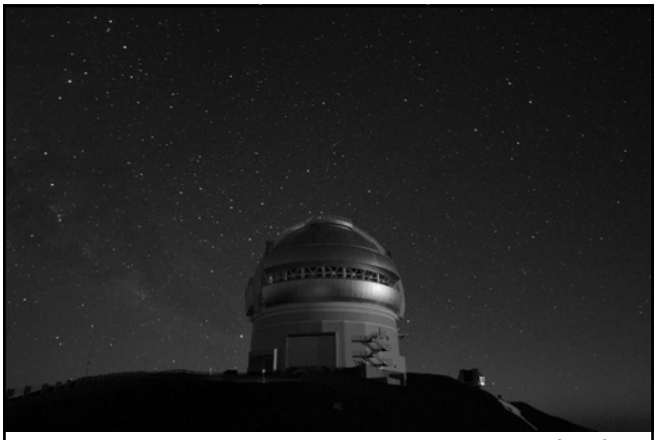
- The longer the focal length, the larger the image
- The bigger the lens, the more light collected
  - ✪ a telescope eyepiece gives additional magnification
  - ✪ ×400 is a reasonable limit for normal viewing

Modern telescopes

- Above: a suite of international telescopes in Hawaii at an altitude of over 4000 m
- One of the Gemini 8 m diameter mirrors



Images courtesy Gemini Observatory/AURA



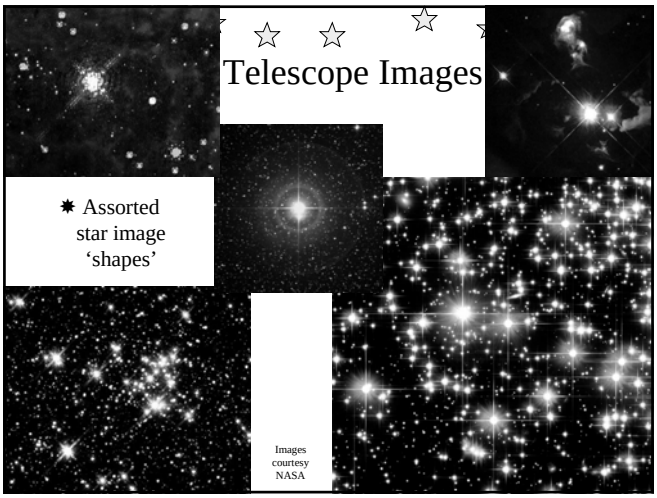
Moonset at Gemini North (Hawaii)

Courtesy: Gemini observatory/AURA

Gemini South (Chile)

Roger Smith picture, courtesy Gemini observatories

Telescope Images



✸ Assorted star image 'shapes'

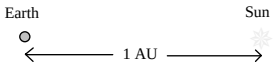
Images courtesy NASA

Units of Distance

✸ Earth's equatorial diameter is 12756 km

✸ **Astronomical Unit** (AU) is now defined as a fixed distance of about 149.598×10^6 km, effectively the average distance between Earth and Sun, more than 10,000 Earth diameters.

✪ the AU is the natural unit to use for solar system distances



✪ Pluto's orbit is 80 AU in diameter, Jupiter's 10.4 AU

✸ Light takes about 8 minutes to travel 1 AU. In 1 year light travels 9.5×10^{12} km in space. This distance is called a **light year** (LY).

Scale of the Universe

✪ to Sun: 8 light min

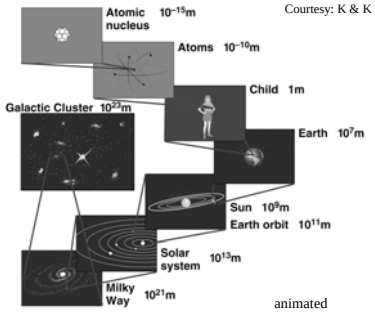
✪ to nearest star: 4.2 LY

✪ across galaxy: 10^5 LY

✪ local cluster: ~10^7 LY

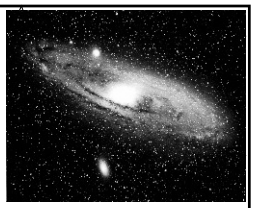
✪ very distant galaxies: ~5×10^9 LY

Courtesy: K & K



animated

Stars in our Galaxy

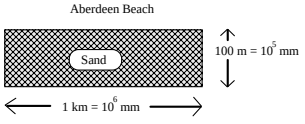


Our sister galaxy Andromeda

✸ There are over 10^{11} stars in our galaxy - a truly astronomical number

✪ the number of grains of sand each occupying 1 mm^2 that can be seen on a strip of Aberdeen's beach 1 km long by 100 m wide is:

$10^6 \times 10^5 = 10^{11}$ grains



Hubble Deep Field

- A stunning enlargement of our view of the universe
- Historical review