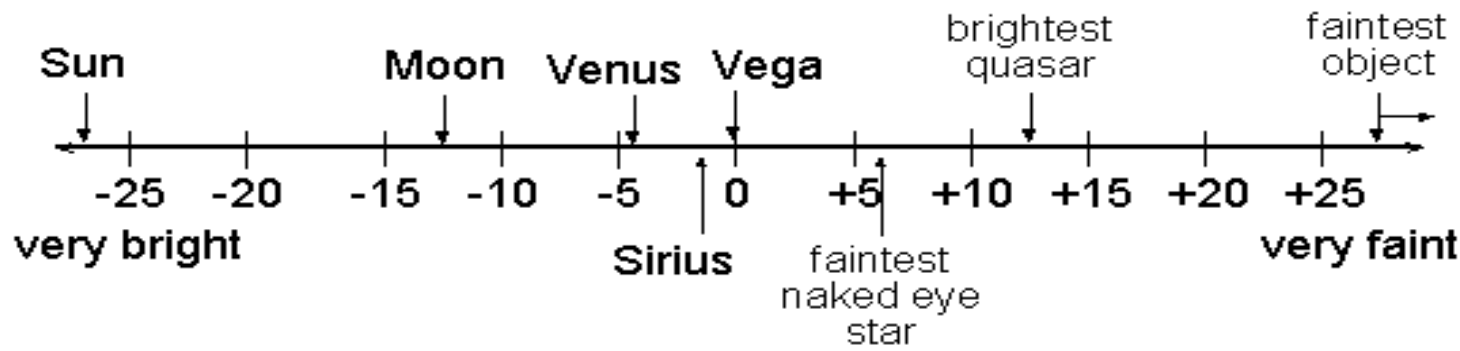


Topic 13: Exploring  
Starlight  
Part One





# Magnitude

Apparent brightnesses of some objects in the magnitude system.

A lower magnitude means a brighter star (e.g., Sirius: -1.46, Vega: 0, Faintest visible: +6).

In calculations apparent magnitude is represented by **m**.

Apparent magnitude **does not** consider distance.

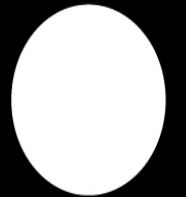
The **absolute magnitude (M)** is how bright a star would appear if placed **10 parsecs away** from Earth.

Helps compare intrinsic brightness of stars.

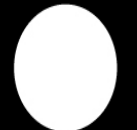
$$M = m + 5 - 5 \log d$$

## Apparent Magnitude

Mag. 1



Mag. 2 x 2.5 dimmer



x 2.5

Mag. 3 x 2.5 dimmer



x 6.25

Mag. 4 x 2.5 dimmer



x 16

Mag. 5 x 2.5 dimmer

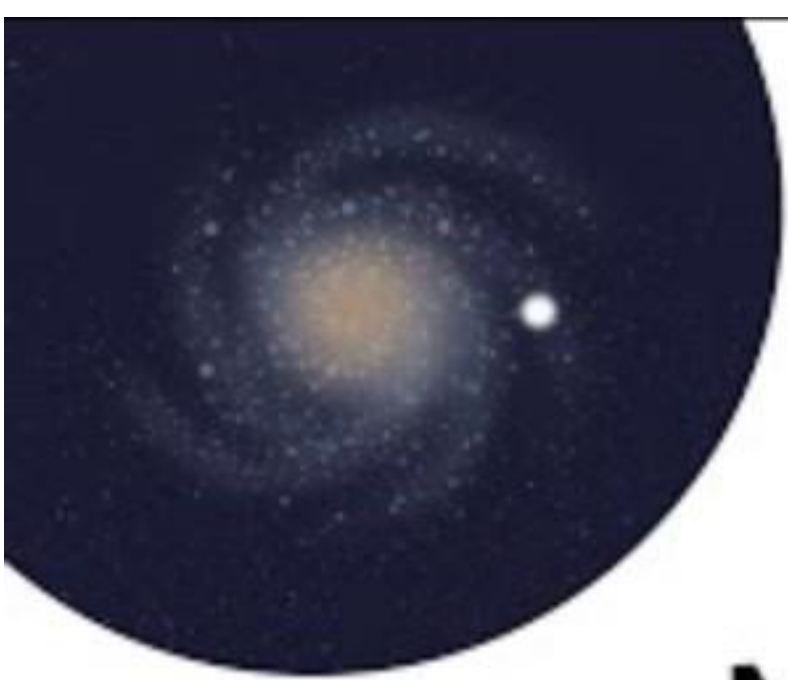


x 40

Mag. 6 x 2.5 dimmer



x 100



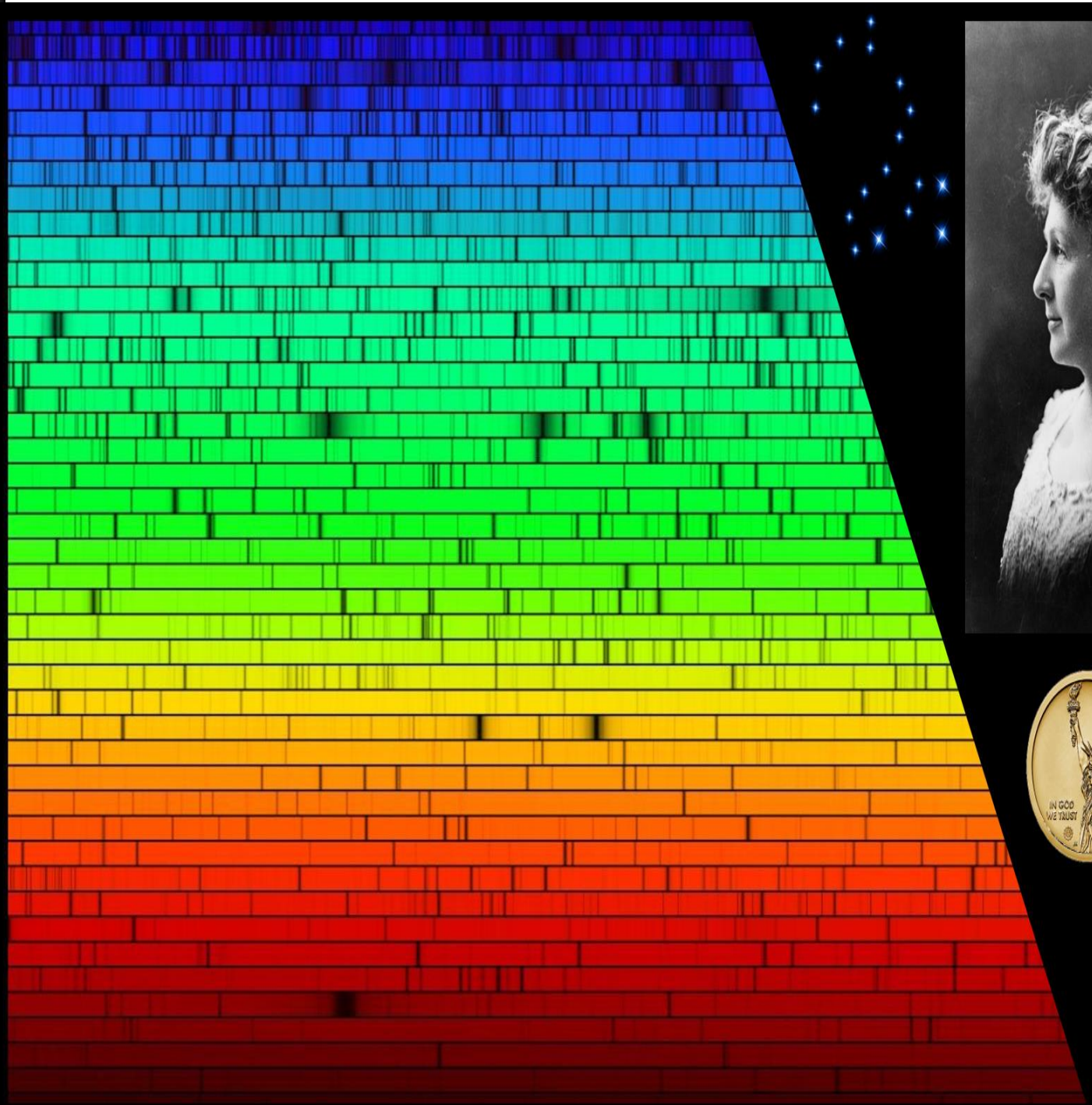
LC  Las Cumbres  
Observatory



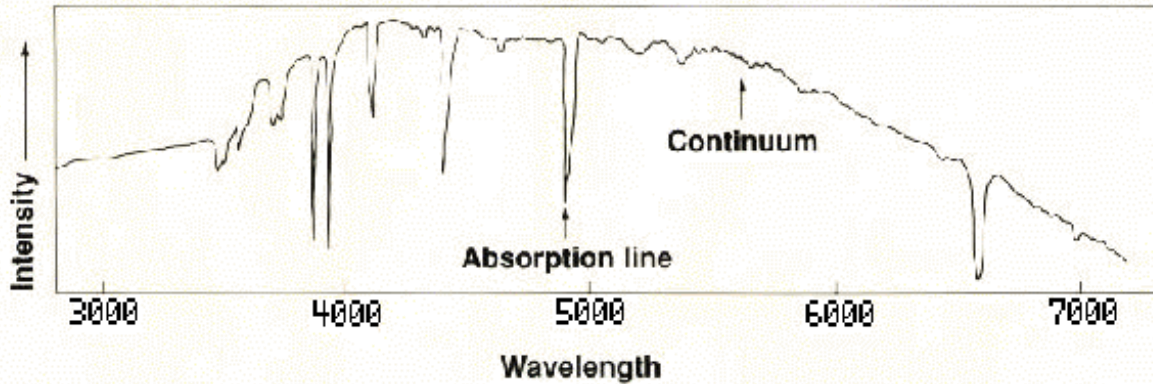
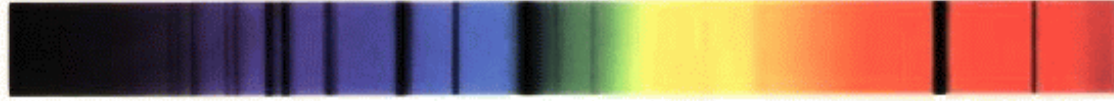
# Magnitude

Brightness and distance





H $\delta$  H $\gamma$  H $\beta$  H $\alpha$



Isaac Newton used a prism to split white light into different colours.

Astronomers use a spectrometer which uses the same principle to study a star's chemical composition, temperature and even its velocity away from or to Earth.

# Classifying Stars

## LINE SPECTRA



Line spectra

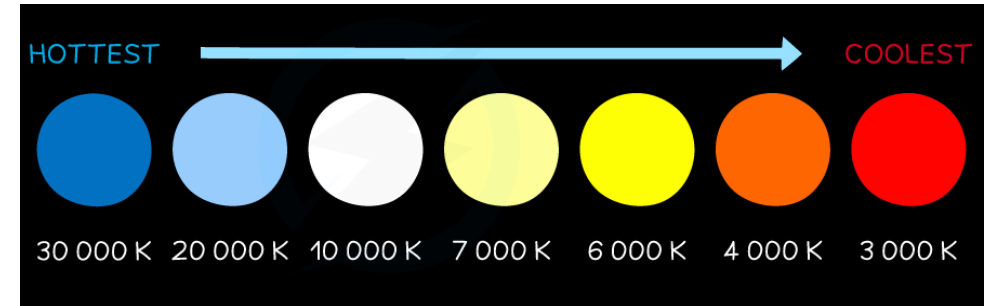
Stars are classified into **spectral types**:  
**O B A F G K M** (hottest → coolest).

Astronomers categorise by temperature and their chemical composition.

Stars are divided into 7 main categories and then given a number between 0 to 9 within each to denote temperature within the category. Distinguishing letters after that you might see such as 'III', 'V', 'VII'

The Sun is classed as a **G2 star (5800K)** .

# Classifying Stars

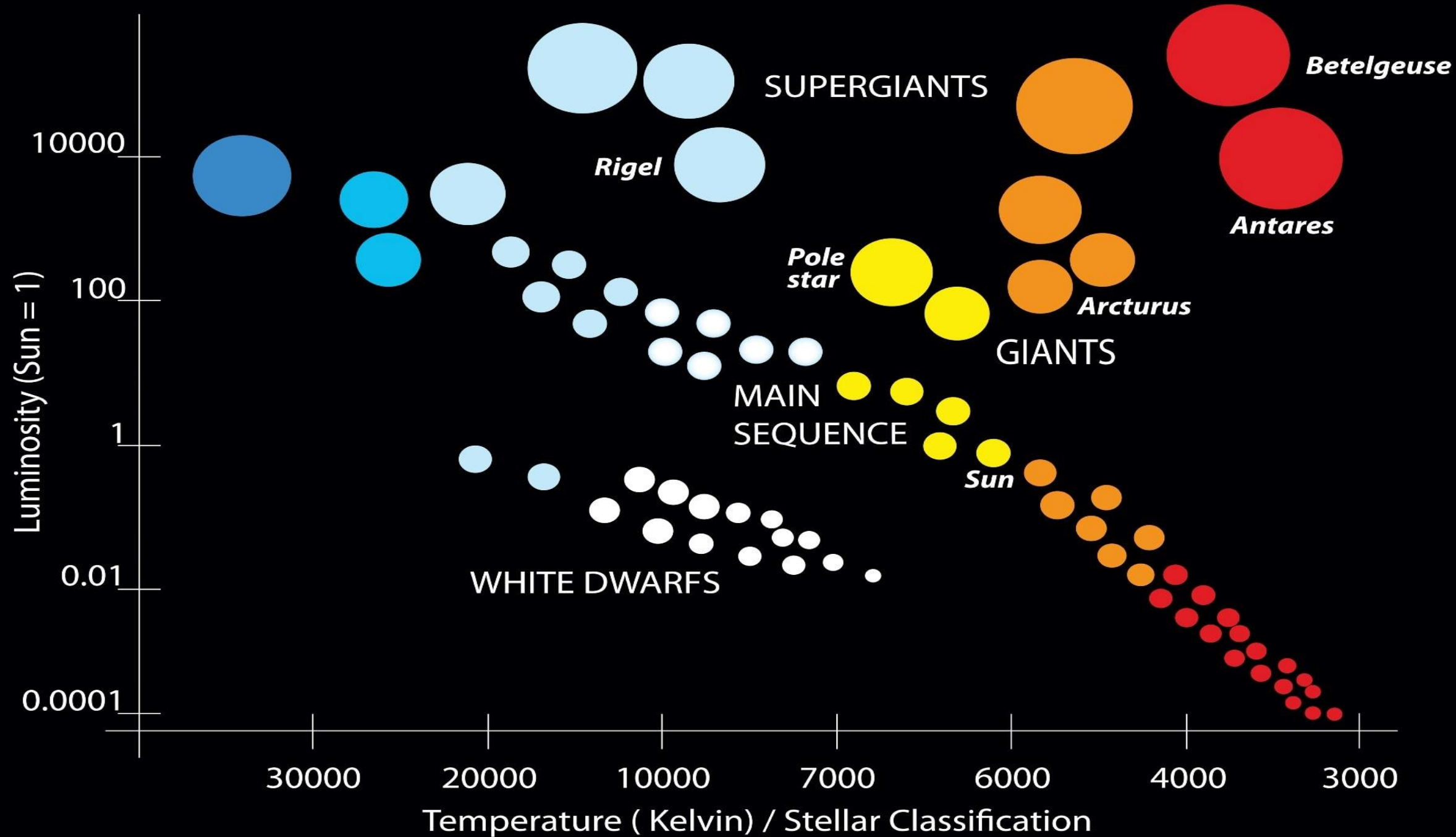


## STELLAR SPECTRAL CLASSES

"Oh Be A Fine Girl/Guy, Kiss Me"

Class	Surface temperature (kelvins)	Spectral characteristics	Example
O	28,000–50,000	Ionized helium; weak hydrogen lines	Alnilam
B	10,000–28,000	Neutral helium; stronger hydrogen lines	Spica
A	7,500–10,000	Strong hydrogen lines; plus magnesium, calcium, iron	Sirius
F	6,000–7,500	Weaker hydrogen lines; singly ionized and neutral metals	Procyon
G	4,900–6,000	Ionized calcium strongest; weaker hydrogen than F	Sun
K	3,500–4,900	Neutral metal lines predominate	Arcturus
M	2,000–3,500	Strong in neutral metals and molecules	Betelgeuse, red/brown dwarfs
L	1,300–2,000	Neutral alkali metals, hydrides	2M1507 (brown dwarf)
T	<1,300	Methane and sodium absorption	Epsilon (ε) Indi Ba (brown dwarf)

The tinted background illustrates star color for each spectral type.



# Luminosity

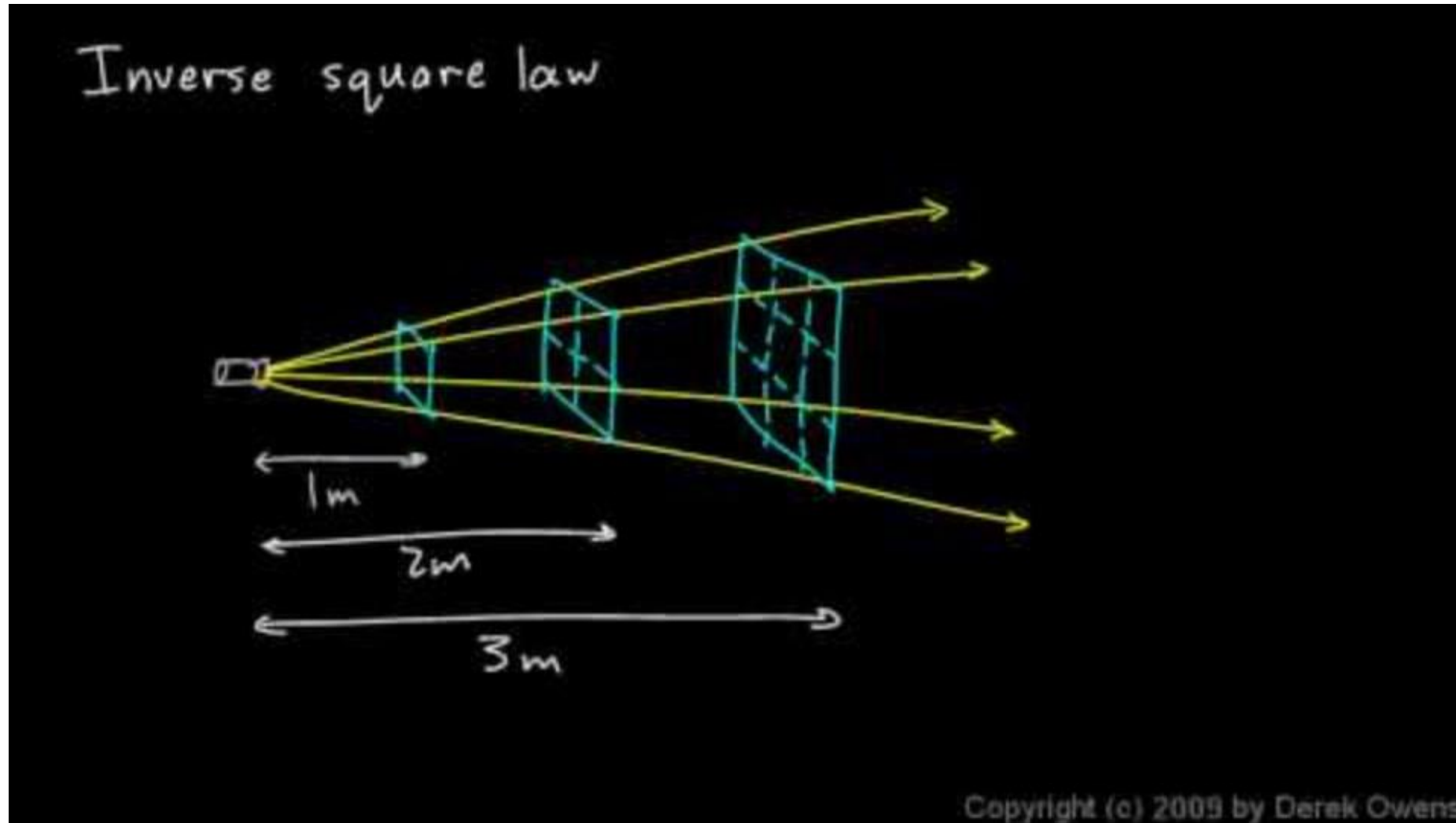
Luminosity is the total amount of light a star emits per second.

It represents its true intrinsic brightness or power output.

Measured in Watts or solar luminosities, it is an inherent property determined by a star's surface temperature and radius.

Unlike apparent brightness, luminosity does not depend on distance.

It is subject to the **inverse square law**.



# Heliocentric Parallax

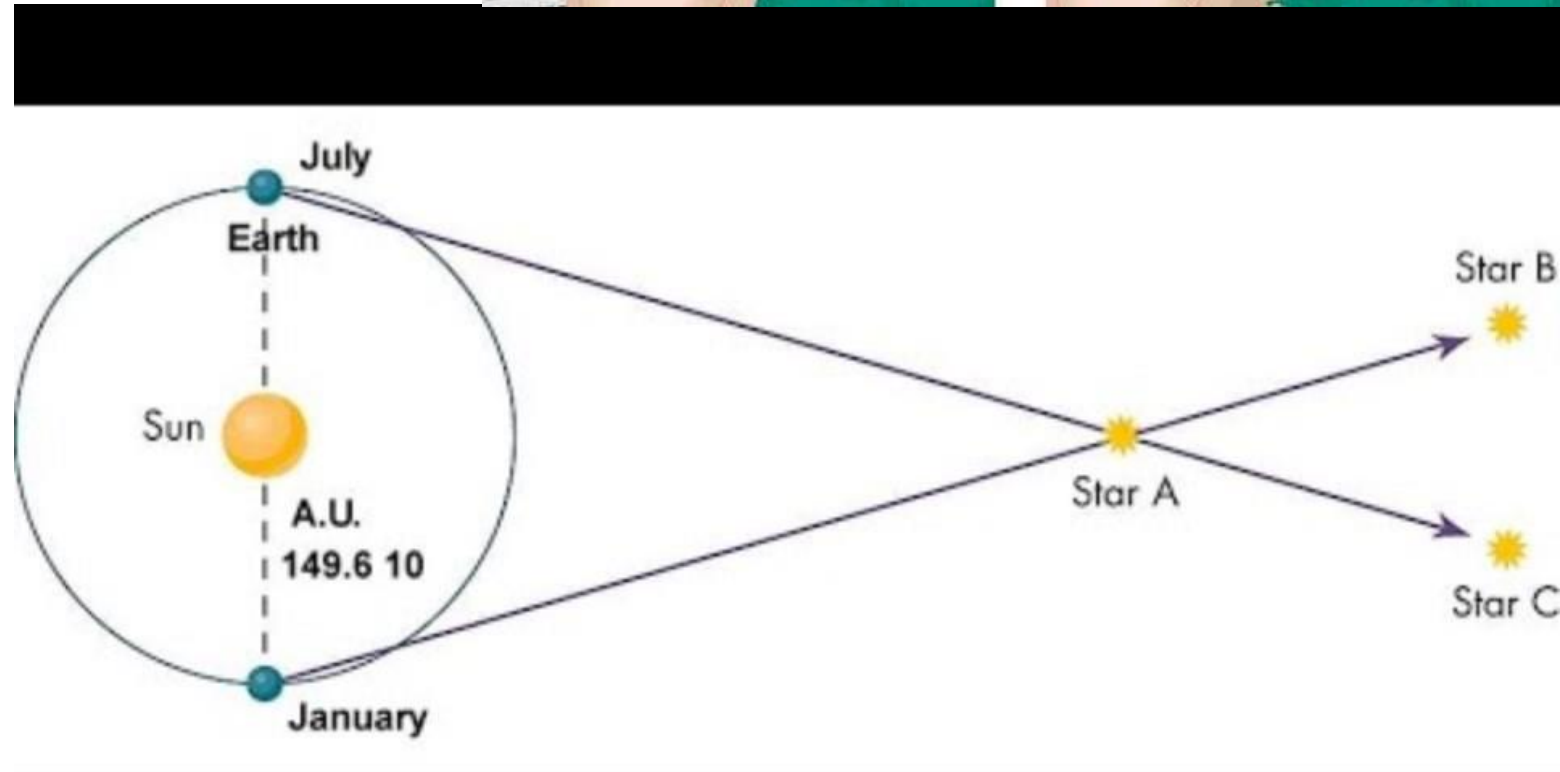
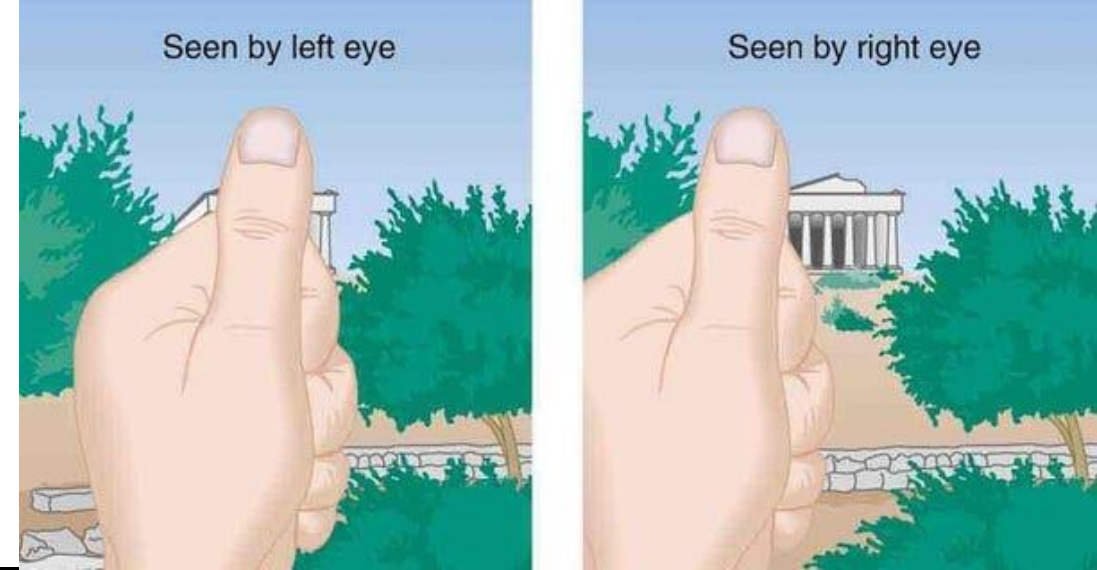
Nearby stars appear to shift against the background when viewed from different positions in Earth's orbit.

Hold your thumb up and close one eye, look at it with the other and see the background behind it. Now repeat it with the other eye and do this a few times.

From Earth, we measure it in one month and then again six months later when the Earth is on the opposite side of the Sun (this is the heliocentric bit!).

By figuring out how much the star moves we can work out the angle and from there the distance using the AU between Earth and Sun as a base to measure by.

We calculate the luminosity of the star and can work out its distance using its apparent brightness to place it on the H-R diagram.

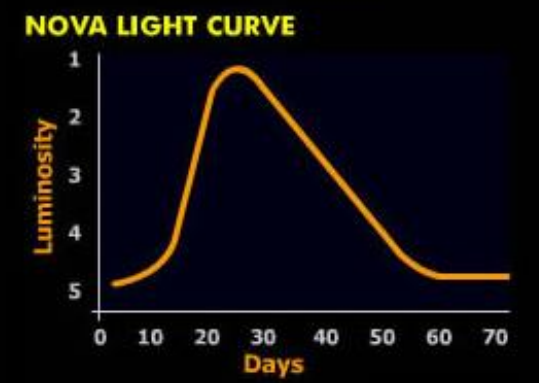
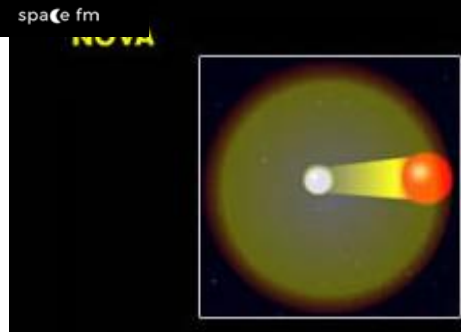
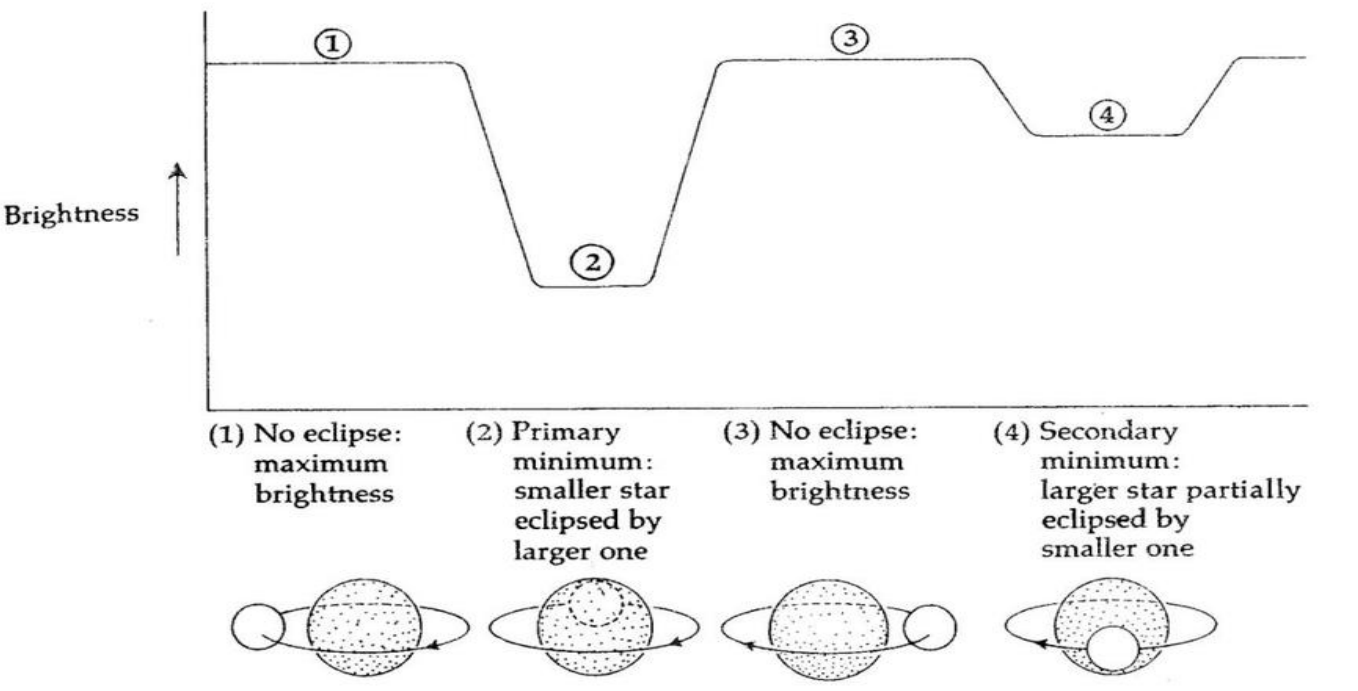
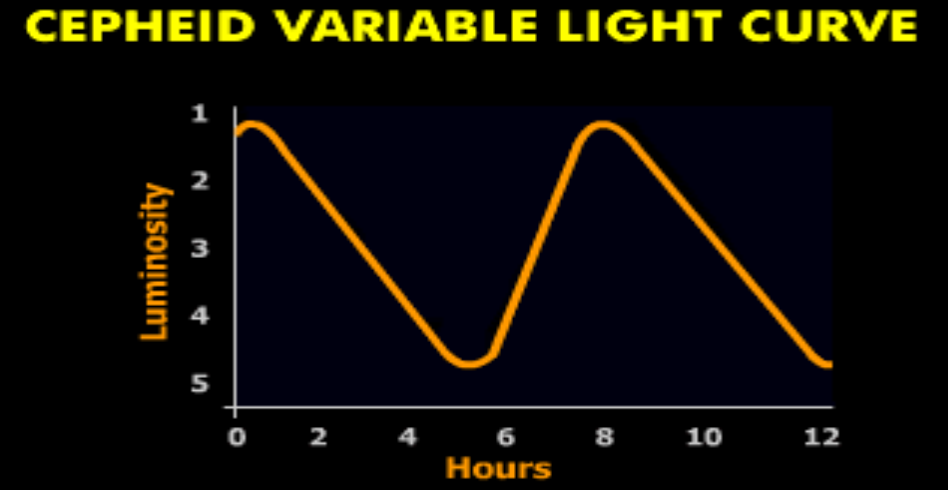
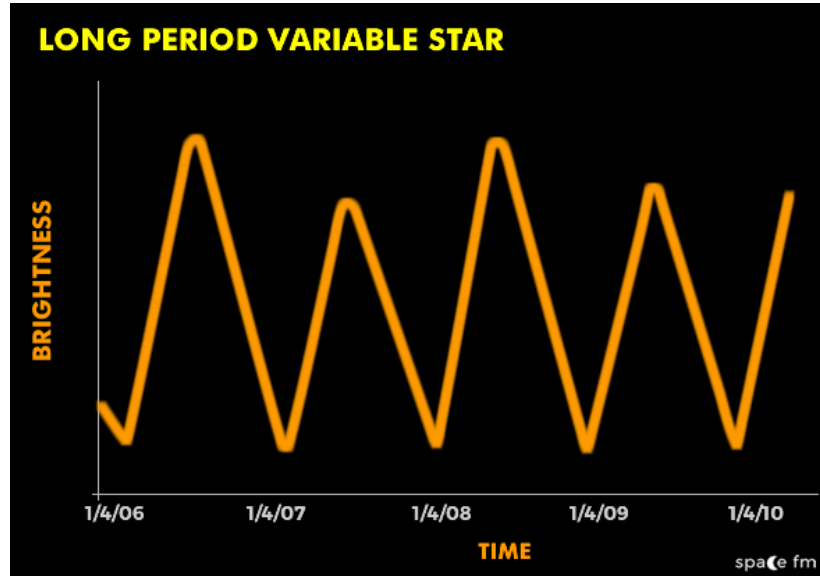


# MEASURING DISTANCES TO STARS



# Variable Stars

Variable stars change brightness over time.



# Astronomy GCSE

## Topic 13

### Light Curves



Topic 13: Exploring  
Starlight  
Part Two



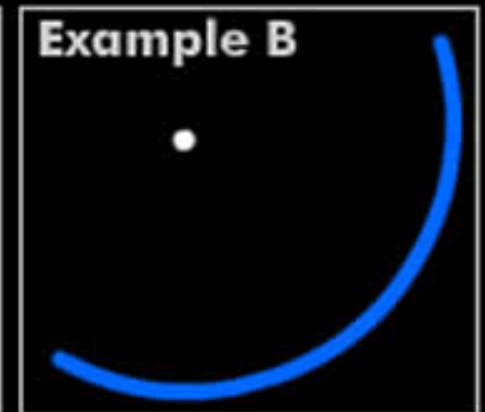
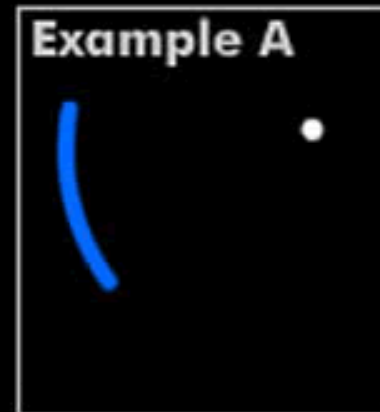
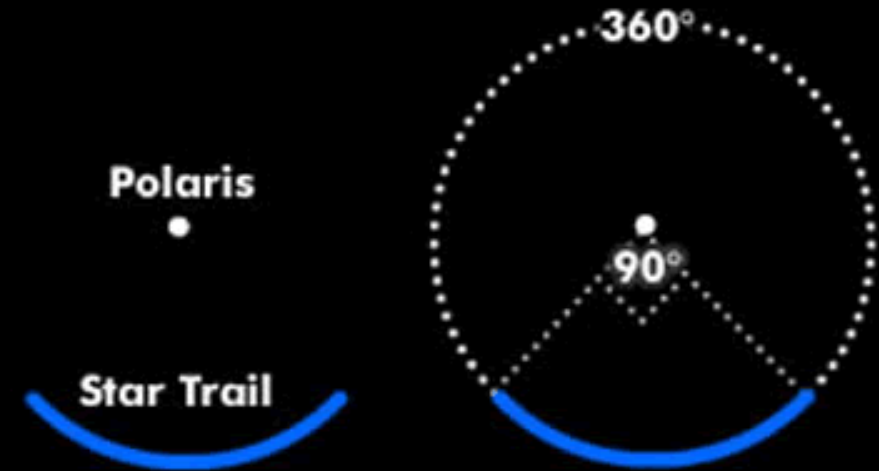
# Star Trails



By looking at how much a prominent star in a star trail photograph has moved we can work out the exposure time of the image.

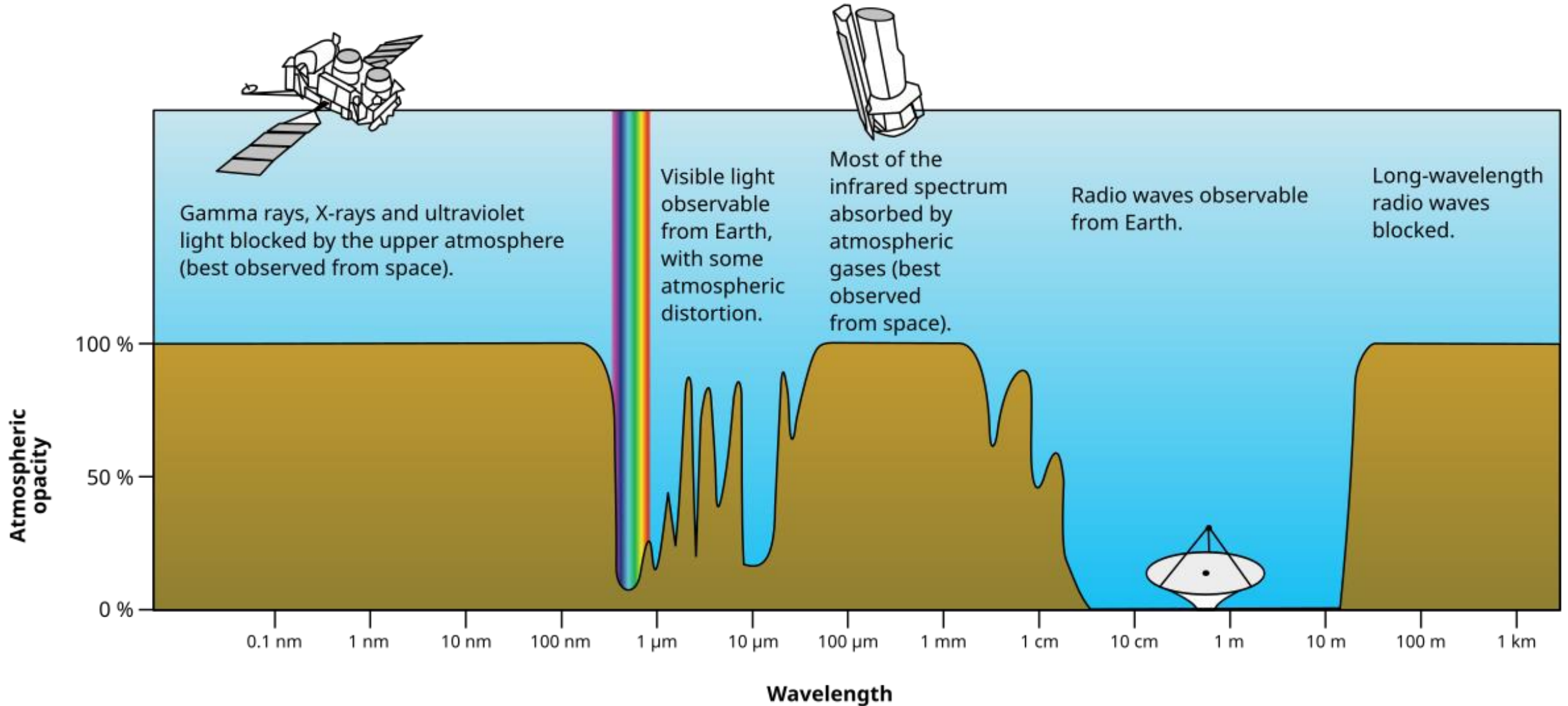
$$\frac{\text{Angle of arc}}{360^\circ} = \frac{\text{Time exposure}}{24 \text{ hours}}$$

## CALCULATING STAR TRAILS



The Earth's atmosphere **blocks most wavelengths**, except visible light and radio waves.

# Telescopy



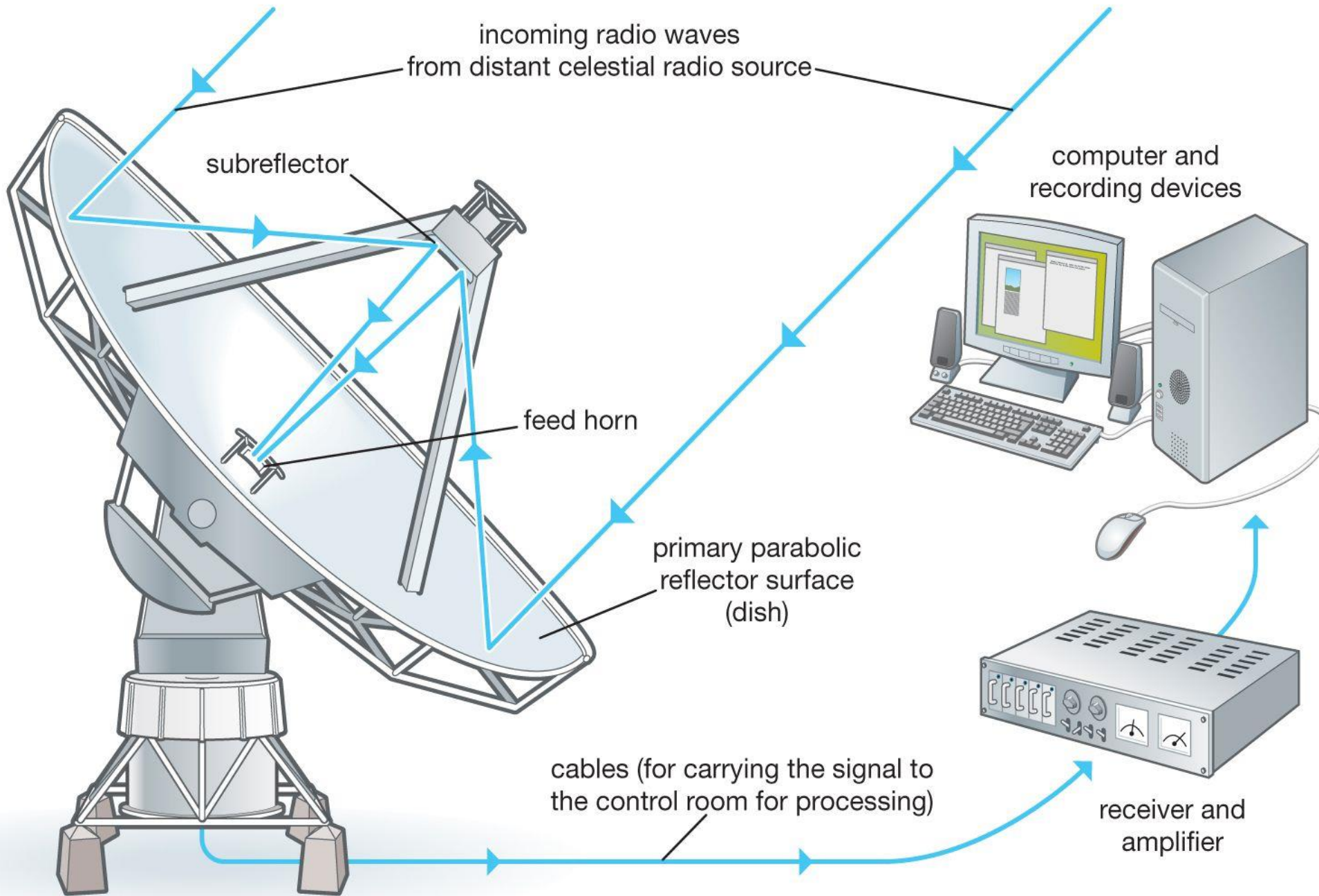
# Observatories

There are 4 main types of astronomical observatories:

- Ground
- Underground
- Airbourne
- Space



# Radio



## **Advantages:**

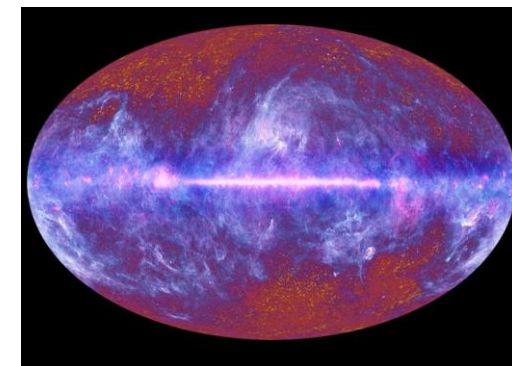
- Connectivity

## **Disadvantages:**

- Interference

## **Major discovery:**

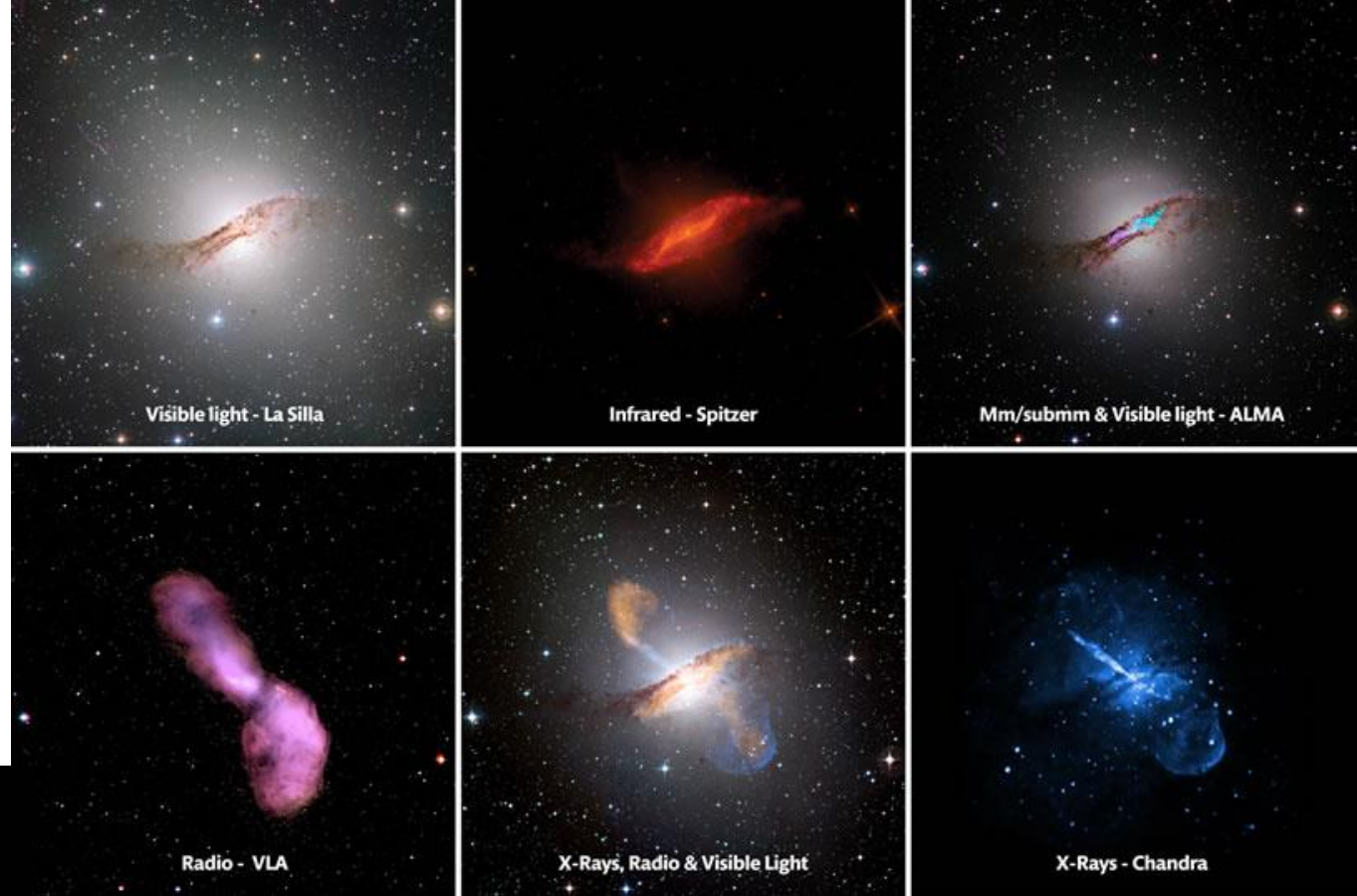
CMB



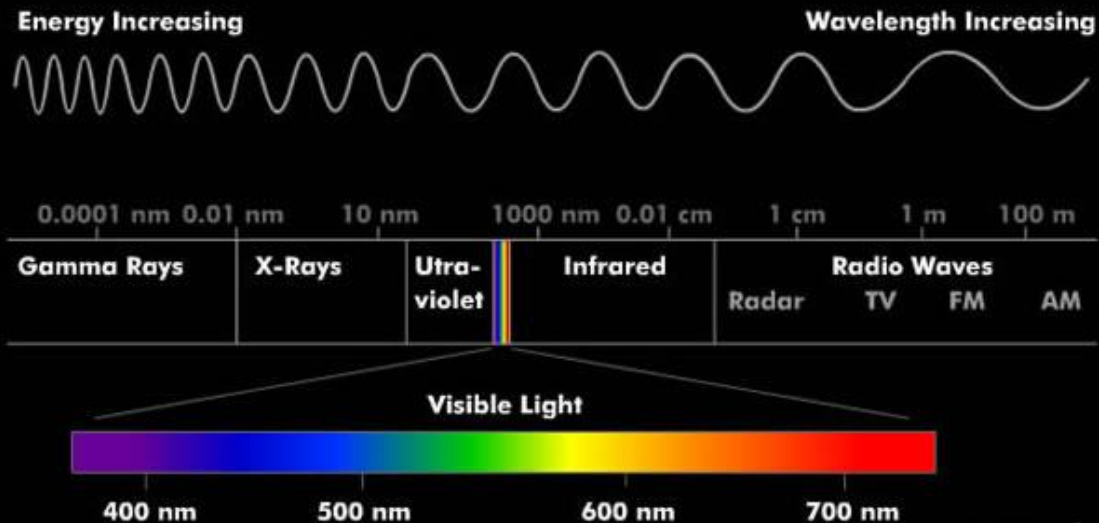
# Invisible Astronomy

Using wavelengths from EM spectrum that we cannot detect from Earth or see with our eyes.

- Radio
- Microwave
- Infrared
- Ultraviolet
- X-ray
- Gamma

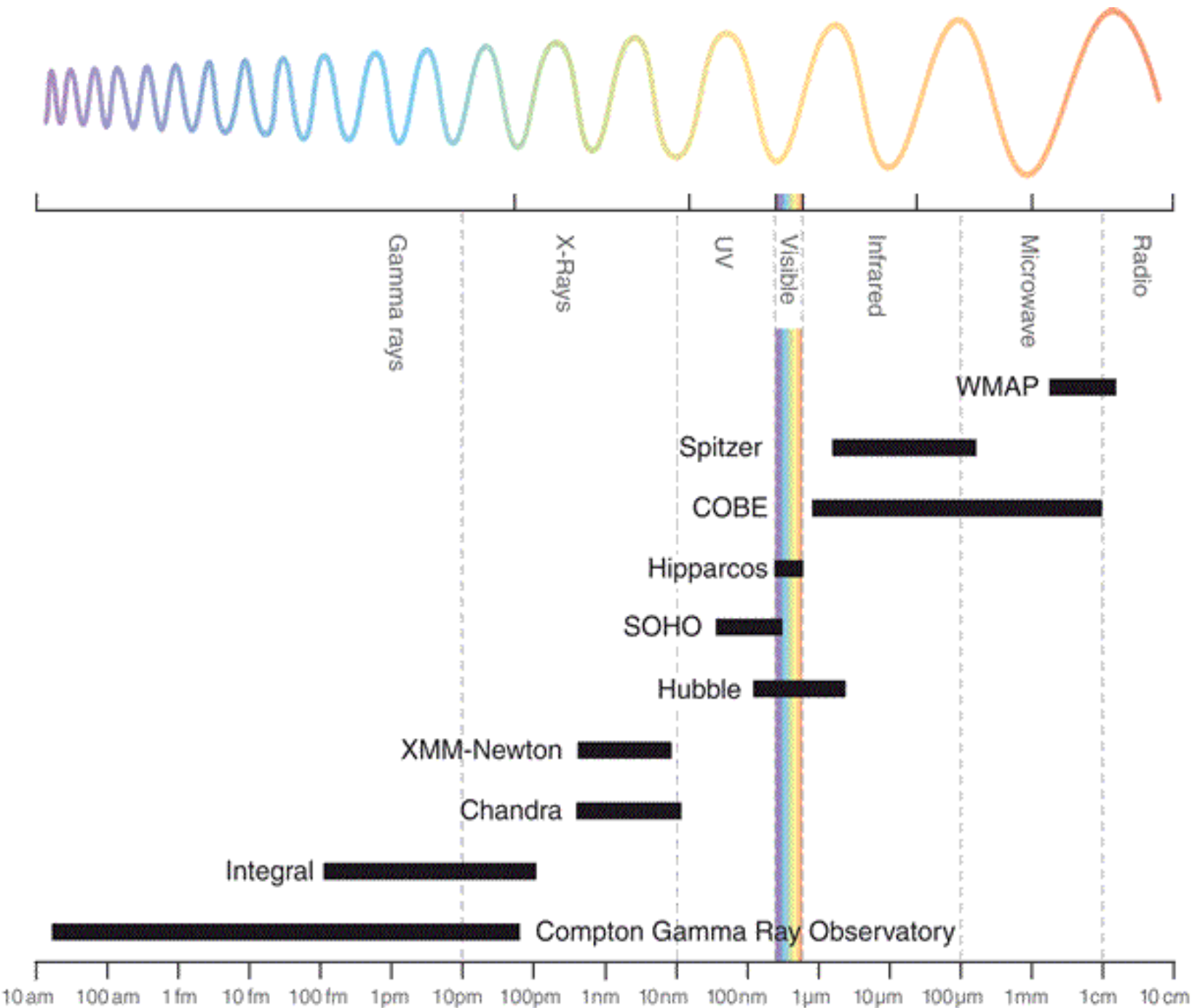


## ELECTROMAGNETIC SPECTRUM



Our knowledge and appreciation of astronomy has increased over the last two decades due to orbiting space telescopes. They have considerable advantages (and disadvantages) over terrestrial observatories.

# Space Telescopes



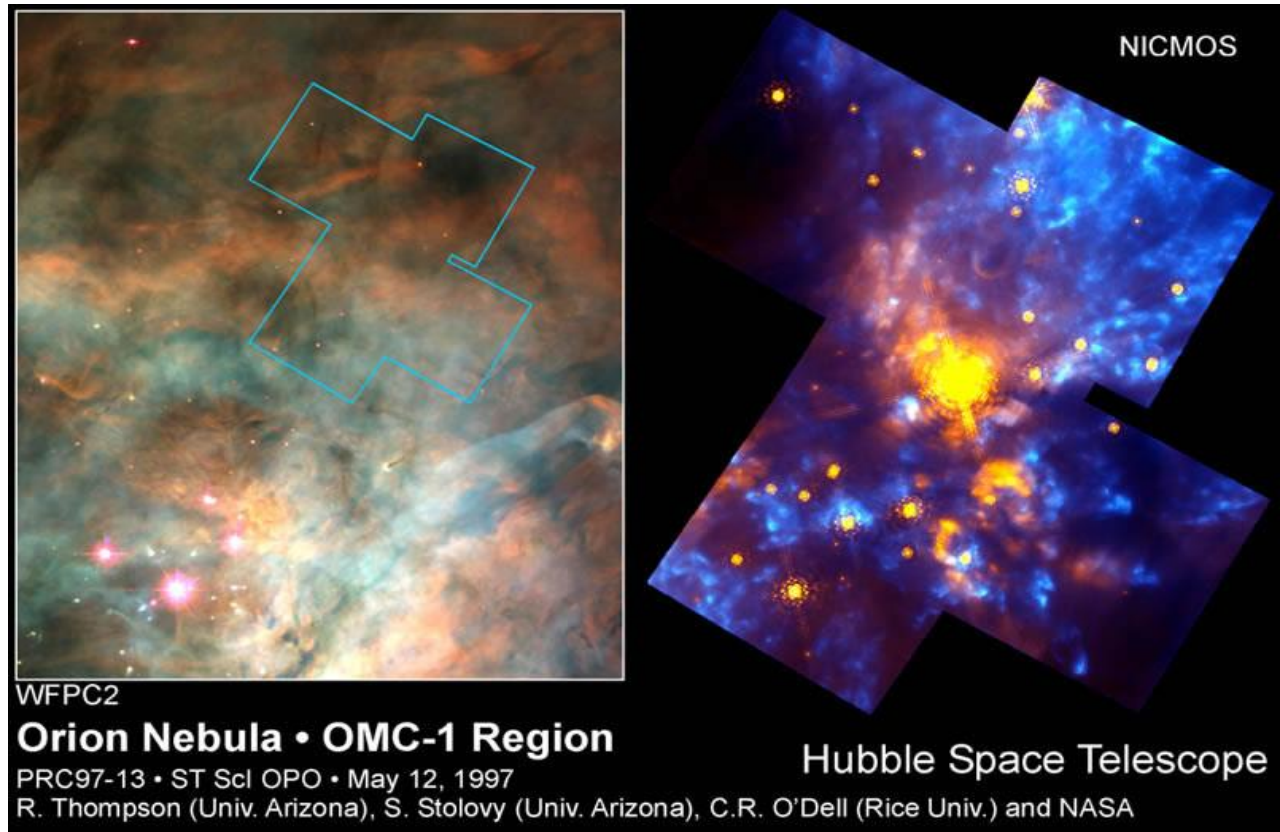
## Advantages

- Clearer observations can be taken. (no atmosphere)
- Wider wavelengths of the electromagnetic spectrum can be observed.
- No limitations to observing at night time, or time limitations.

## Disadvantages

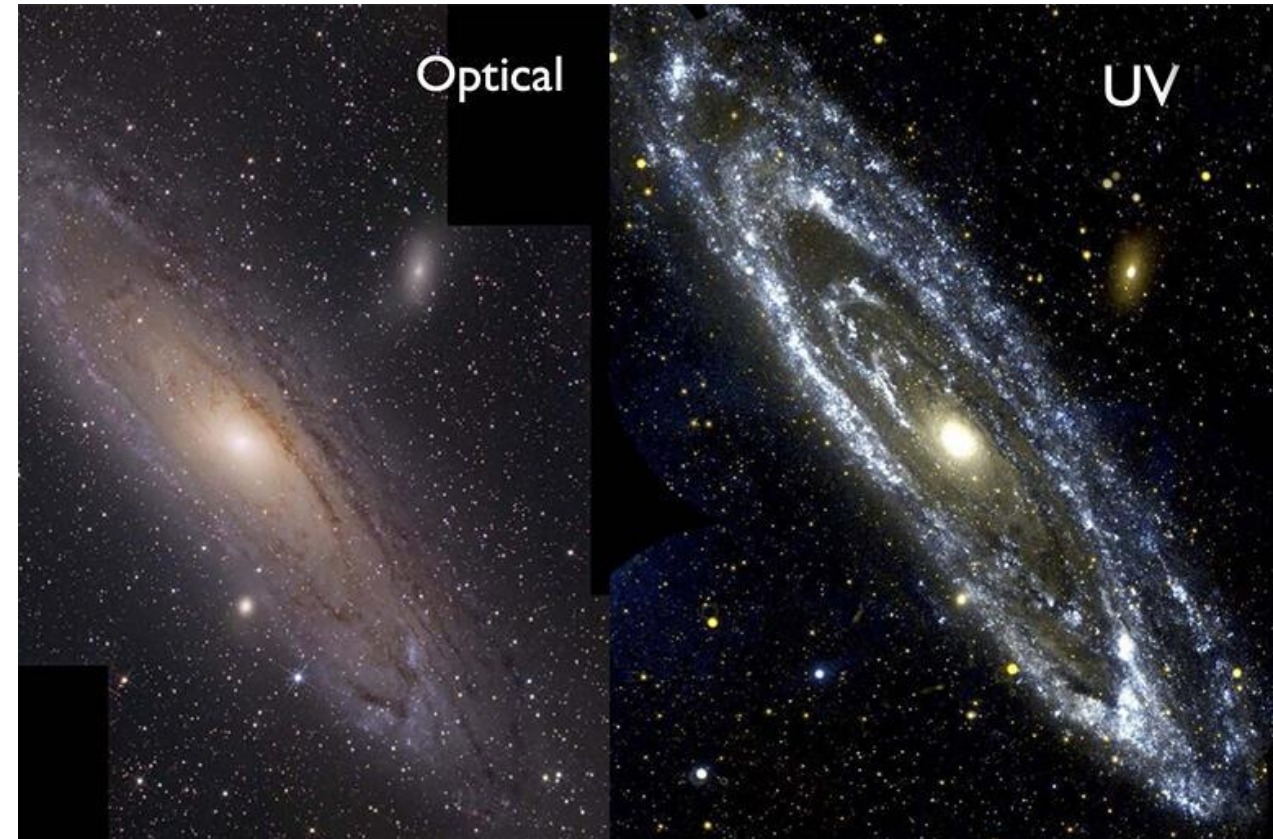
- There are some limitations with imaging solar system objects due to light sensitivity.
- They are exceptionally expensive to build and position in place.
- Maintenance is difficult.

# Infrared



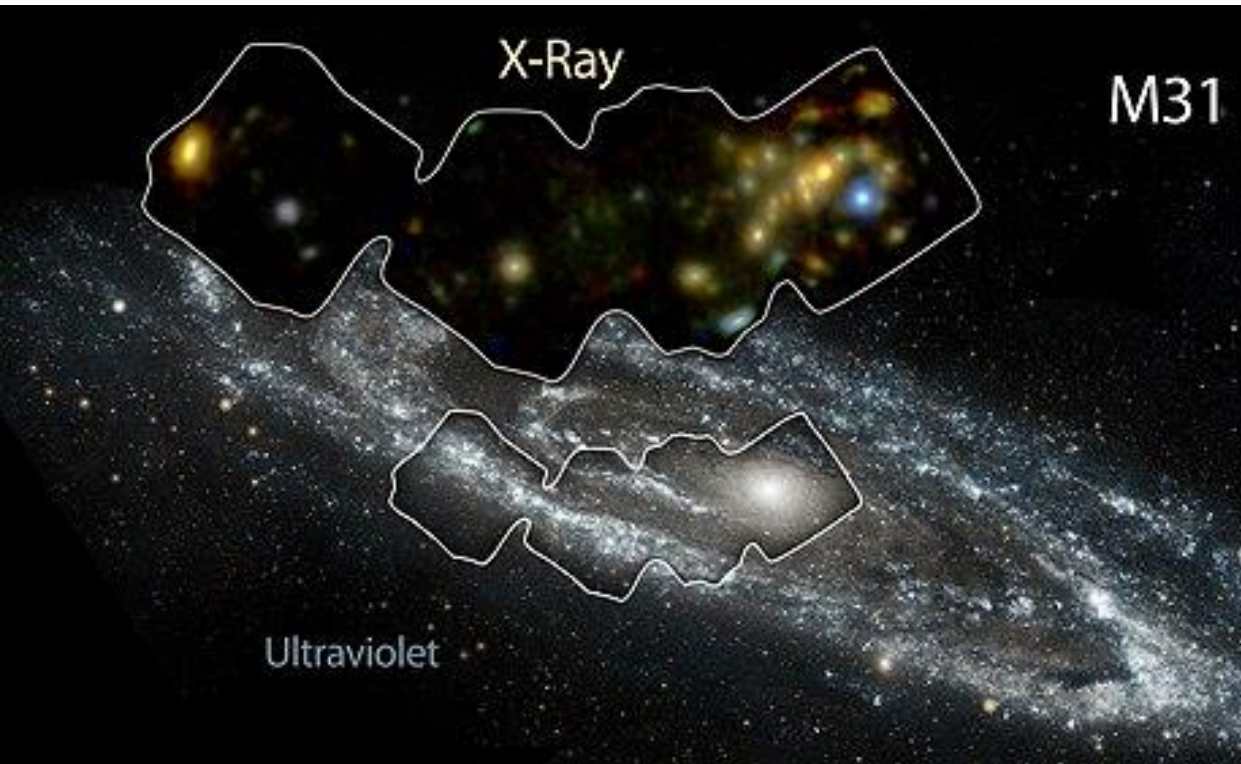
Infrared allows astronomers to see past cooler dust and gas to see objects generating heat.

# Ultraviolet



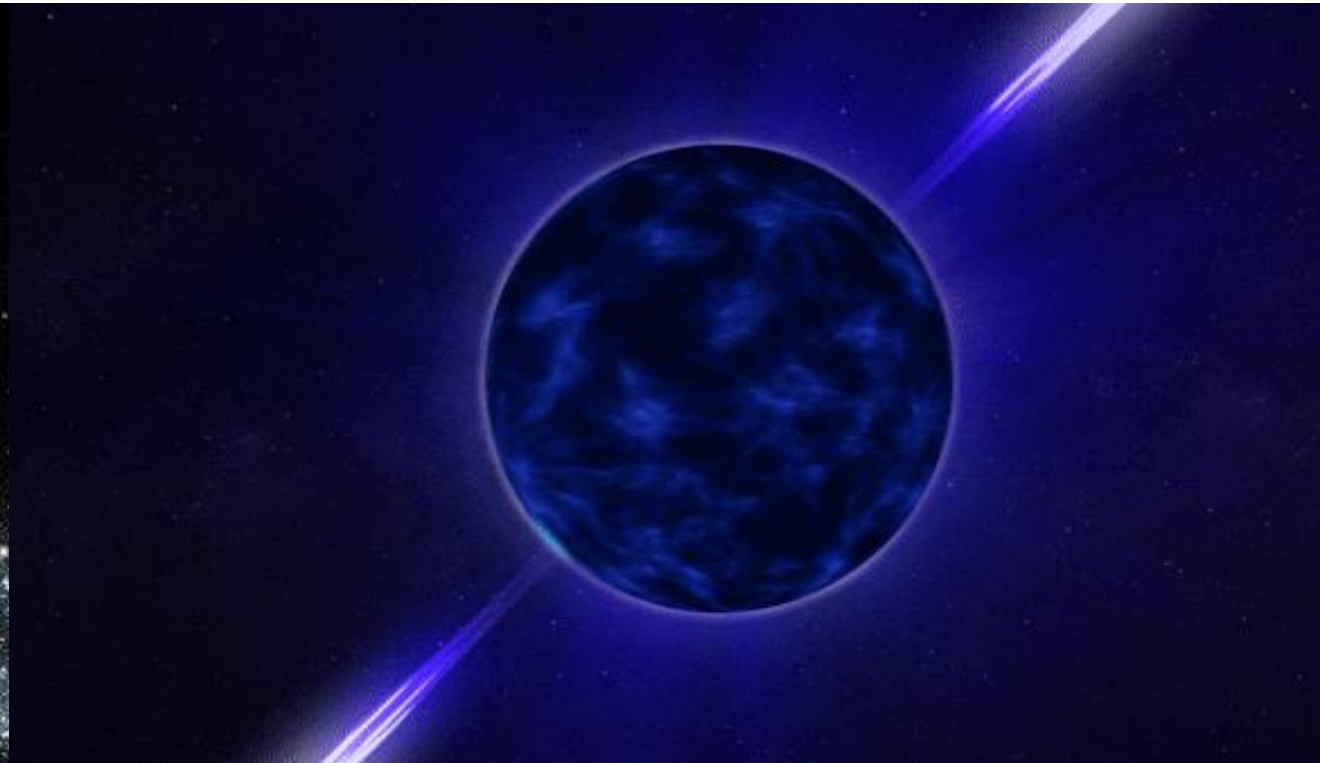
Ultraviolet observation lets us study the composition and temperature of stars. Ultraviolet radiation is the signature of hotter objects, typically in the early and late stages of their evolution.

# X-ray



X-Rays are produced by hotter objects outside of the visual band of the electromagnetic spectrum. Black holes gather matter in an accretion disc. The effect of fast-moving particles under strong gravitational forces that surround a black hole can be observed in the x-ray part of the spectrum.

# Gamma



Gamma rays are emitted during a supernova when a high mass star collapses to a neutron star or black hole. Most bursts last a fraction of a second so although they can be detected, capturing the unpredictable moment they occur is difficult.

Some neutron stars emit pulses of gamma from the poles. (**pulsars**)

