

### The Solar System

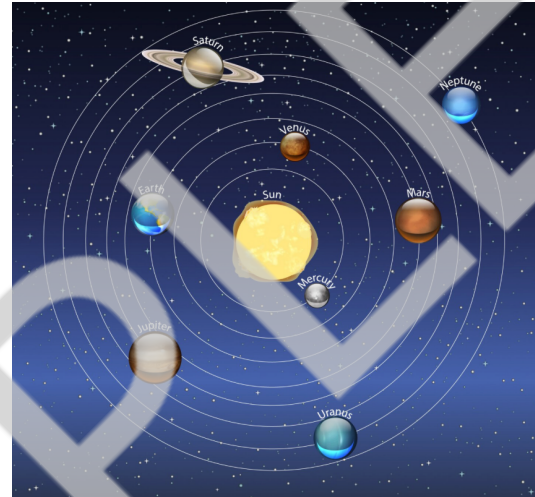
A **solar system** is a star with **planets, moons, asteroids and comets orbiting** it

Our system is **heliocentric** meaning **the Sun is at the centre**

**8 planets orbit the Sun in the same general plane**

Planets orbit due to **gravitational attraction** between them and the Sun

- Smaller planets are **rocky**
- larger planets are **gas giants**



#### Models of the Solar System:

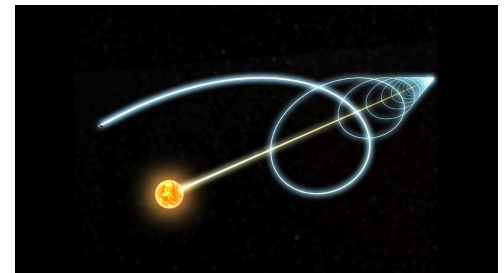
1. **Geocentric (old model)**
  - Earth at centre
  - Everything moves in perfect circles

2. **Heliocentric (correct model)**

- Sun at centre

#### Evidence:

- **Retrograde motion** → Mars appears to move backwards  
→ caused by Earth overtaking Mars
- **Galileo** → moons orbit Jupiter (not Earth)
- **Kepler** → orbits are **elliptical**, not circular



#### Planetary Orbits

- Gravity provides a **centripetal force**  
→ which constantly changes the direction of motion

**Velocity changes direction** → so the planet is accelerating even at constant speed

#### Orbital Speed Equation:

$$v = \frac{2\pi r}{T}$$

#### What it means:

v = orbital speed  
r = orbital radius (distance from the Sun)  
T = time for one orbit

- Distance travelled in one orbit = circumference =  $2\pi r$
- Speed = distance ÷ time
- Closer to star → **stronger gravity**  
→ **higher speed needed to stay in orbit**

So, because Earth's orbital radius is 149.6 million km, and one orbit takes 365 days (8,766 hours), we can calculate the Earth's orbital speed as follows:

**939,950,000 =  $2\pi r$  where r = 149.6 million km**

**$\frac{939,950,000 \text{ km}}{8,766 \text{ hours}} = 107,226 \text{ km/h}$**

Gravity

**Gravitational Field Strength** is defined as **force per unit mass**

Gravitational field strength tells you how much force acts on each kilogram of mass

**Orbital Speed Equation:**

$$g = \frac{F}{m}$$

g = gravitational field strength (N/kg)

F = gravitational force (N)

m = mass (kg)

**Weight Equation:**

**Weight** is the force acting on an object due to gravity

$$W = mg$$

W = weight (N)

m = mass (kg)

g = gravitational field strength (N/kg)

**Because:**

**Weight = gravitational force**

**Mass stays constant**, but **g changes** depending on planet

because **Mass ≠ Weight**

**Mass:**

- Amount of matter
- Constant
- Measured in kg

**Weight:**

- Force due to gravity
- Changes depending on planet
- Measured in newtons (N)

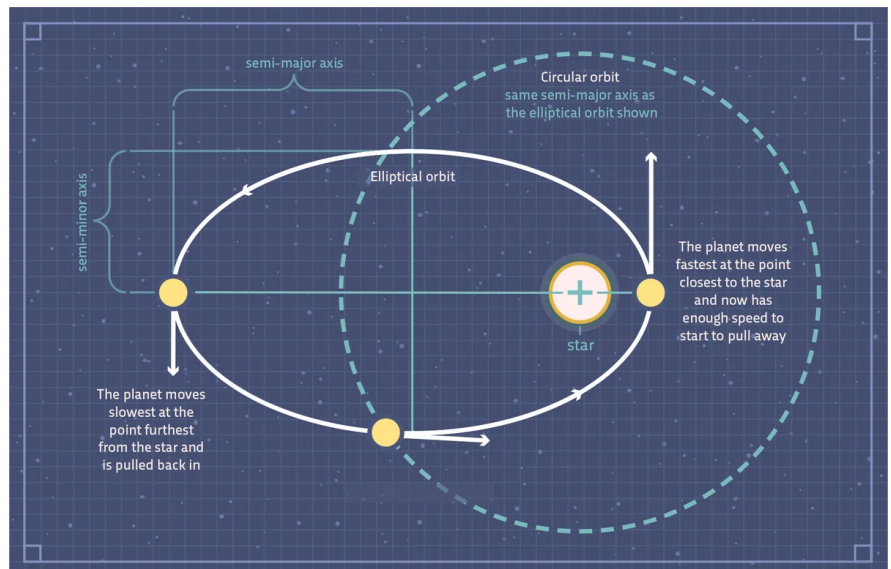
**Motion in the Universe**

- ⇒ Universe → billions of galaxies
- ⇒ Galaxy → billions of stars
- ⇒ Solar system → planets

**Elliptical Orbits:**

**Objects move faster when closer to the star** because gravity is stronger there

- Planetary orbits are slightly elliptical
- Comets are highly elliptical



## Stars

### Colour & Temperature

Blue = hottest

Red = coolest



### Brightness

Two types:

- **Apparent magnitude** = how bright it looks from Earth
- **Absolute magnitude** = brightness at a fixed distance (10 parsecs)

### The Life Cycle of a Star

#### 1. Formation

- ⇒ Stars start as a **nebula** (gas + dust)
- ⇒ **Gravity pulls particles together** → temperature increases
- ⇒ **Nuclear fusion** begins

#### 2. Fusion

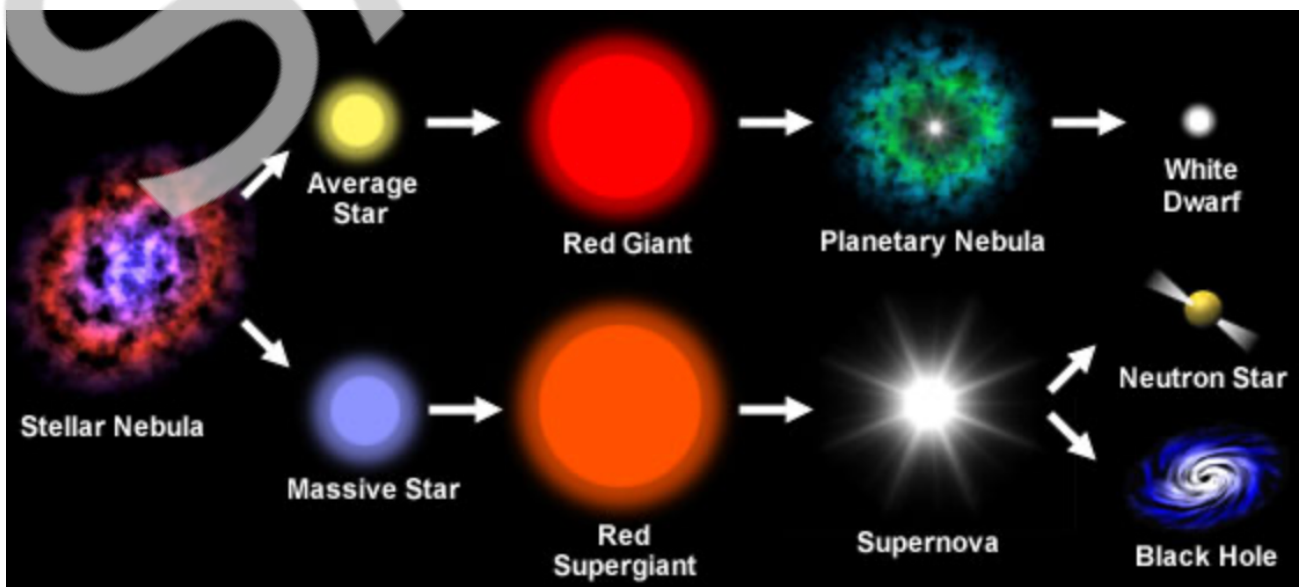
**Hydrogen nuclei fuse** → turning them into helium

- This reaction releases energy
- Energy creates **outward pressure**
- This **balances gravity** → forms a **stable star (main sequence)**

#### 3. End of Life:

**Average stars (like the Sun):** Red giant → planetary nebula → white dwarf → black dwarf

**Massive stars:** Red supergiant → supernova → neutron star / black hole



**Hertzsprung–Russell (HR) Diagrams**

Shows relationship between:

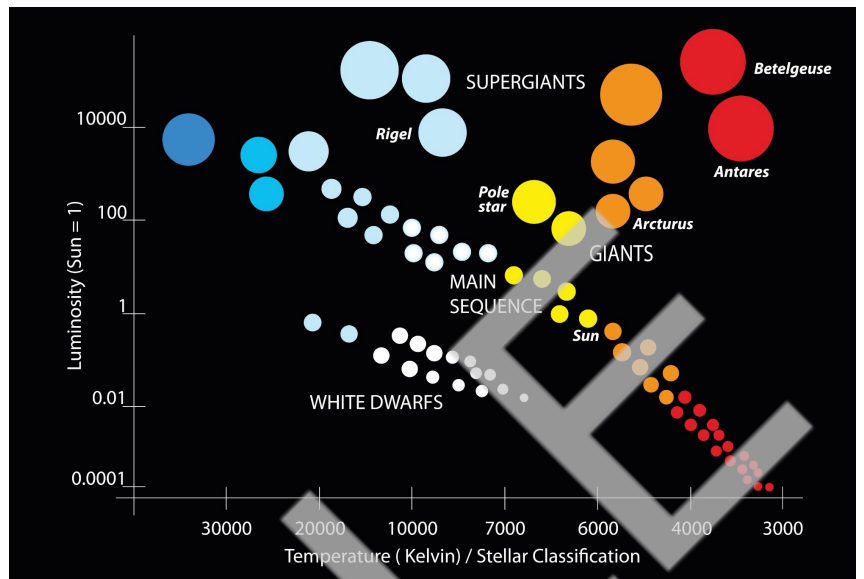
**Temperature (x-axis)**

And

**Luminosity/brightness (y-axis)**

Main regions within the diagram:

- Main sequence (diagonal)
- Red giants (top right)
- White dwarfs (bottom left)



**Red Shift**

Travelling light shifts toward the **red end** of spectrum  
→ **wavelength increases**

This happens because **Galaxies are moving away**  
→ **Doppler effect**

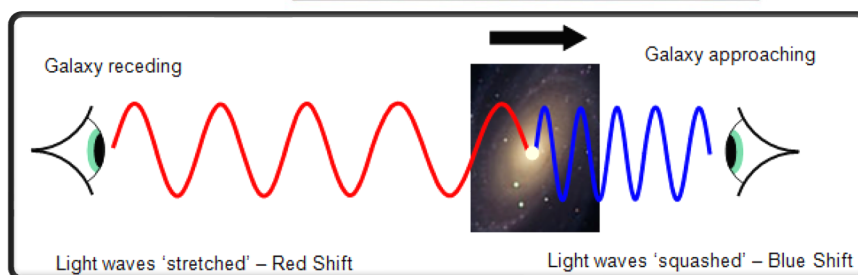
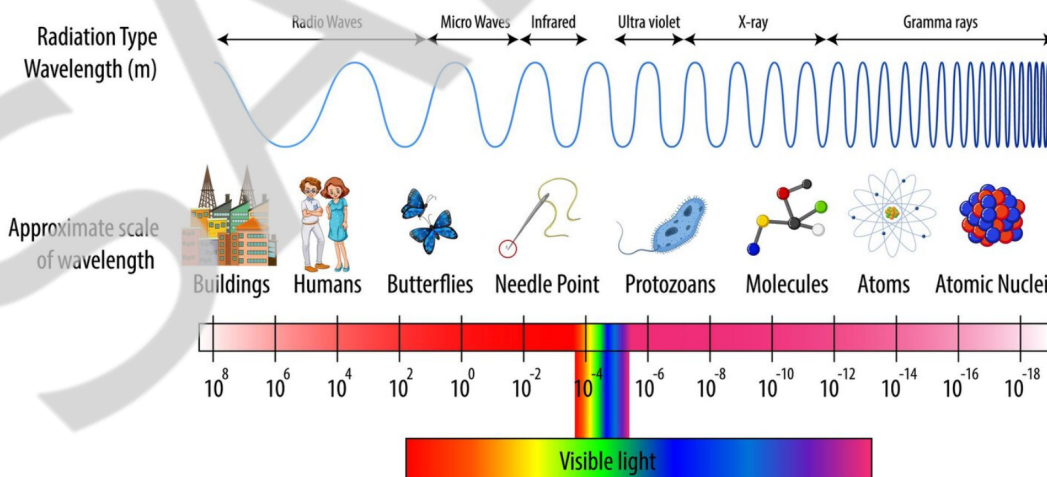
**Doppler Equation:**

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

The change in wavelength **depends on the speed** of the galaxy

Further galaxies → moving away faster  
→ Universe is **expanding**

**THE ELECTROMAGNETIC SPECTRUM**



### The Big Bang Model

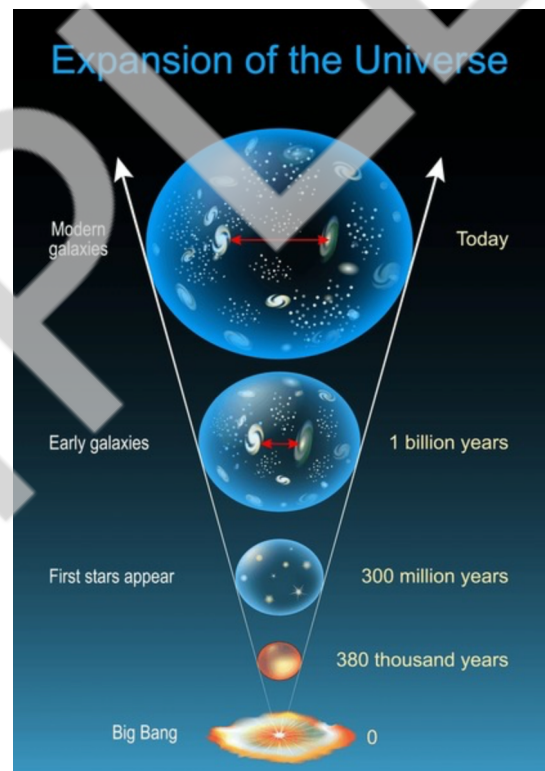
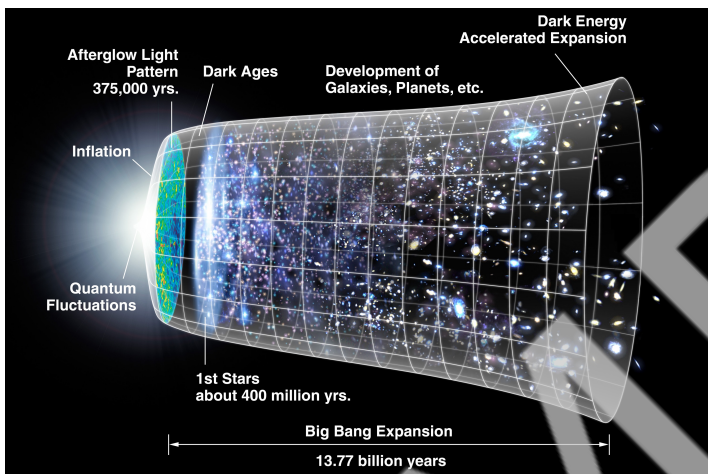
The universe began from **a single point** and **has been expanding ever since**

#### Evidence for the Big Bang

1. **Red Shift** shows **galaxies are moving away** → universe is expanding
2. **Cosmic Microwave Background (CMB)**

⇒ The early universe was very hot → it emitted **high-energy radiation**  
 ⇒ As the universe expanded this **radiation was stretched** → now **microwaves**

As it has been detected in all directions it is very strong evidence for the Big Bang Theory



**Everything Links!**

**Gravity** → causes orbits  
**Orbits** → require centripetal force  
**Fusion** → balances gravity in stars  
**Red shift** → shows expansion  
**Expansion** → supports Big Bang

**Top Exam Pitfalls to Avoid**

- “Planets need a force to keep moving forward” → no, **only to change direction**
- “Acceleration means speeding up” → no, also **change in direction**
- “Red shift = colour change only” → actually **evidence of motion**
- “Stars explode randomly” → depends on **mass and fusion stages**

**In short:**

- Gravity controls motion in space
- Fusion powers stars
- Star mass determines its life cycle
- Light from galaxies shows the universe is expanding
- This supports the Big Bang theory