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GCSE AQA Physics Topic 8

Topic 8: Space Physics (Triple Science)

8.1 Solar System; Stability of Orbital Motions; Satellites

8.1.1 Our Solar System

- Our solar system includes:
  - One star (the Sun)
  - Eight planets
  - Dwarf planets
  - Natural satellites (moons orbiting planets)
- The solar system is a small part of the Milky Way galaxy.
- Our model is called the 'heliocentric model' , the evidence was based on Mars' retrograde motion.

Orbits-

- The gravitational force of the sun causes the planets to change direction constantly
- Therefore velocity is always changing, **the planets are accelerating without going quicker**.

- For a stable orbit:

- If the planet moves closer to the sun

  - The gravitational attraction to the sun increases
  - So the orbital speed of the planet increases

8.1.2 The Life Cycle of a Star

- **Star Formation:**
  - Gas and dust in a galaxy are pulled together by gravity.
  - The cloud of gas and dust becomes more concentrated, increasing pressure and temperature.
  - Fusion begins when particles fuse to form helium, releasing energy.

    - This energy counteracts gravitational collapse, leading to star formation.
- **Star Evolution:**
    - **For Stars Much Bigger than the Sun:**
        - The star collapses, increasing pressure and temperature.
        - Heavier elements fuse.
        - The star eventually explodes in a supernova.
        - The remaining core becomes either a neutron star or a black hole.
    - **For Stars Similar in Size to the Sun:**
        - Fusion continues but is less extensive.
        - The star eventually collapses and forms a planetary nebula.
        - The core remains as a white dwarf.

8.1.3 Orbital Motion, Natural and Artificial Satellites

- **Orbital Motion:**
    - Gravity maintains the circular orbits of planets and satellites.
    - Gravitational force changes the direction of the object, altering its velocity but not its speed.
    - Orbital speed changes with the orbital radius:
        - Closer to the central object = increased speed.
        - Further from the central object = decreased speed.

8.2 Red-Shift

- **Observations:**
    - Increased wavelength of light from distant galaxies.
    - More distant galaxies show greater redshift, indicating they are moving faster.
- **Implications:**
    - Redshift suggests the universe is expanding.
    - Supports the Big Bang theory, which proposes the universe originated from a hot, dense state.

Current Evidence For Big Bang:

- **Red Shift**- when the **wavelength of light** from a distant object (like a galaxy) appears **longer** — shifted towards the **red end** of the spectrum.

- This happens because the **object is moving away** from us.

  The expansion shown by red-shift supports the idea that the universe **started from a single point** and has been **expanding ever since** — this is evidence for the **Big Bang theory**.

What is the CMB (Cosmic Microwave Background) Radiation?

- The **CMB** is **radiation left over from the Big Bang**.
- It is **microwave radiation** that fills the entire universe — it's everywhere, coming equally from all directions.
  It is one of the **strongest pieces of evidence** that the **universe began from a very hot, dense state** and has been **expanding and cooling ever since**.

How it formed (CMB)

1. Around **380,000 years after the Big Bang**, the universe had **expanded and cooled** enough for atoms (mostly hydrogen) to form.
2. Before that time, the universe was full of **hot plasma** (charged particles) — light couldn't travel freely because it was constantly scattered.
3. Once neutral atoms formed, **radiation could travel freely** through space — this is the radiation we now detect as the **CMB**.
4. Over billions of years, as the universe expanded, this radiation was **stretched (red-shifted)** from **visible/infrared** wavelengths into the **microwave region** of the spectrum.