

Modelling the universe

5.5.1

(c) Describe the formation of a star, such as our sun, from interstellar dust and gas

- Dust and gas cloud drawn in together by gravitational forces
- Atoms in cloud lose potential as they move towards each other, so gain kinetic energy
- Fusion of hydrogen nuclei begins when temperature becomes high enough
- Star becomes stable when outward radiation pressure equals inward gravitational pressure; hydrostatic equilibrium
- Main sequence star

(d) Describe the sun's probable evolution into a red giant and white dwarf

- When all H is used up in core of sun, only fusion products will be left, which begin to fuse
- Outer layers of sun will begin to expand
- Core shrinks
- Red giant formed which eventually becomes a white dwarf

(e) Describe how a star much more massive than our sun will evolve into a super red giant and then either a neutron star or black hole

- After all H is used up inside core, star becomes super red giant
- Fusion of He takes place
- Gravitational collapse of core takes place
- Star explodes (supernova)
- Neutron star or black hole forms

(h) & (i) State and interpret Olber's paradox to explain why it suggests that the model of an infinite, static universe is incorrect

- Universe is infinite
- Each line of sight ends on star, so sky bright at night
- Not true, so implies that universe is finite

(k) Describe and interpret Hubble's redshift observations

- Hubble looked at some data from galaxies
- Spectrum from galaxies had been red-shifted
- Waves have been stretched (Doppler shift), meaning the galaxies are receding from earth

(l) State and interpret Hubble's law

- The speed of recession of a galaxy is directly proportional to its distance from earth
- Galaxies are moving away from us, so universe must be expanding
- All matter and energy must have originated at a single point
- Resolves Olbers paradox

(o) Describe and explain the significance of the 2.7K microwave background radiation

- Uniform intensity in all directions, shows ripples
- Produced when matter and radiation decoupled
- Universe becomes transparent
- Was originally gamma radiation
- Radiation red-shifted towards microwave as universe expanded
- Evidence that universe began with a big bang
- Temperature corresponds with that predicted by big bang model

5.5.2

(c) Describe qualitatively the evolution of the universe 10^{-43} s after the big bang to the present

- All matter and energy concentrated at a single point
- All four forces unified; rapid expansion occurring
- Gravitational force separates, primordial quark soup stage plus photons
- Strong force separates, leptons form from photons
- Weak and electromagnetism separate, protons and neutrons formed
- Helium nuclei form, universe is in plasma form
- CMB formed, atoms form, universe is transparent
- Heavy elements form from gravitational collapse of first stars
- Present day