

Chapter 25. Stars and the Universe

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protostar, red giant, red supergiant, supernova, supernovae, bulge, arm, recede, recession, scatter, spectrum, spectra, spectroscopy, luminosity

6.2 Stars and the Universe

6.2.1 The Sun as a star

Core

- 1 Know that the Sun is a star of medium size, consisting mostly of hydrogen and helium, and that it radiates most of its energy in the infrared, visible and ultraviolet regions of the electromagnetic spectrum

Supplement

- 2 Know that stars are powered by nuclear reactions that release energy and that in stable stars the nuclear reactions involve the fusion of hydrogen into helium

6.2.2 Stars

Core

- 1 State that:
 - (a) galaxies are each made up of many billions of stars
 - (b) the Sun is a star in the galaxy known as the Milky Way
 - (c) other stars that make up the Milky Way are much further away from the Earth than the Sun is from the Earth
 - (d) astronomical distances can be measured in light-years, where one light-year is the distance travelled in (the vacuum of) space by light in one year

Supplement

- 2 Know that one light-year is equal to 9.5×10^{15} m
- 3 Describe the life cycle of a star:
 - (a) a star is formed from interstellar clouds of gas and dust that contain hydrogen
 - (b) a protostar is an interstellar cloud collapsing and increasing in temperature as a result of its internal gravitational attraction
 - (c) a protostar becomes a stable star when the inward force of gravitational attraction is balanced by an outward force due to the high temperature in the centre of the star

- (d) all stars eventually run out of hydrogen as fuel for the nuclear reaction
- (e) most stars expand to form red giants and more massive stars expand to form red supergiants when most of the hydrogen in the centre of the star has been converted to helium
- (f) a red giant from a less massive star forms a planetary nebula with a white dwarf star at its centre
- (g) a red supergiant explodes as a supernova, forming a nebula containing hydrogen and new heavier elements, leaving behind a neutron star or a black hole at its centre
- (h) the nebula from a supernova may form new stars with orbiting planets

6.2.3 The Universe

Core

- 1 Know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years
- 2 Describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies
- 3 Know that the light emitted from distant galaxies appears redshifted in comparison with light emitted on the Earth
- 4 Know that redshift in the light from distant galaxies is evidence that the Universe is expanding and supports the Big Bang Theory

Supplement

- 5 Know that microwave radiation of a specific frequency is observed at all points in space around us and is known as cosmic microwave background radiation (CMBR)
- 6 Explain that the CMBR was produced shortly after the Universe was formed and that this radiation has been expanded into the microwave region of the electromagnetic spectrum as the Universe expanded
- 7 Know that the speed v at which a galaxy is moving away from the Earth can be found from the change in wavelength of the galaxy's starlight due to redshift
- 8 Know that the distance of a far galaxy d can be determined using the brightness of a supernova in that galaxy
- 9 Define the Hubble constant H_0 as the ratio of the speed at which the galaxy is moving away from the Earth to its distance from the Earth; recall and use the equation

$$H_0 = \frac{v}{d}$$

- 10 Know that the current estimate for H_0 is 2.2×10^{-18} per second

- 11 Know that the equation

$$\frac{d}{v} = \frac{1}{H_0}$$

represents an estimate for the age of the Universe and that this is evidence for the idea that all the matter in the Universe was present at a single point

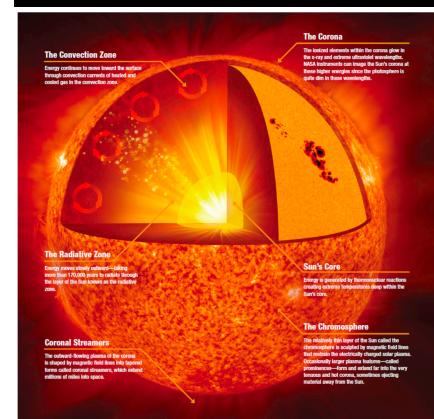
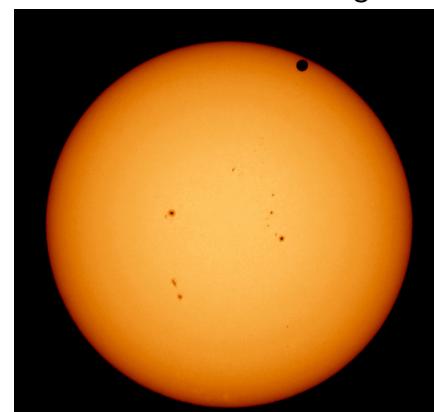
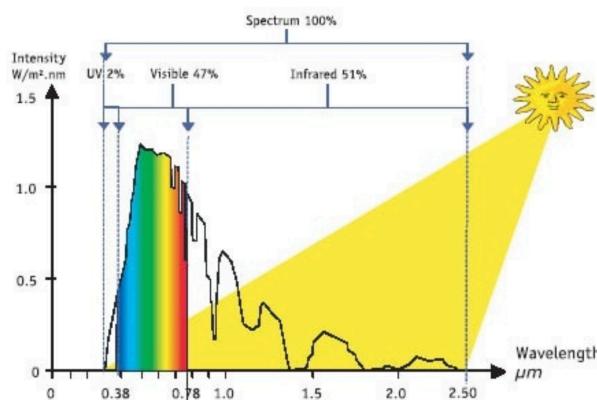
25.1 The Sun

Size:

Element composition:

Spectrum:

SOLAR SPECTRUM

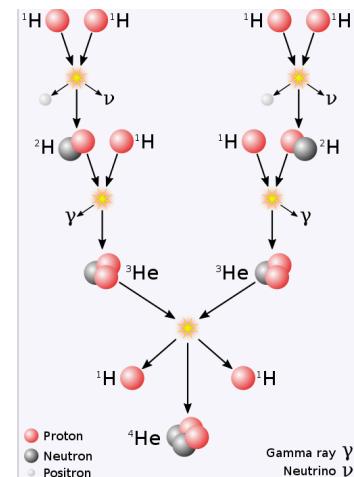


Where does solar energy come from?

Nuclear fusion in core:

Where did the photo we see come from? core or photosphere?

Stable star:

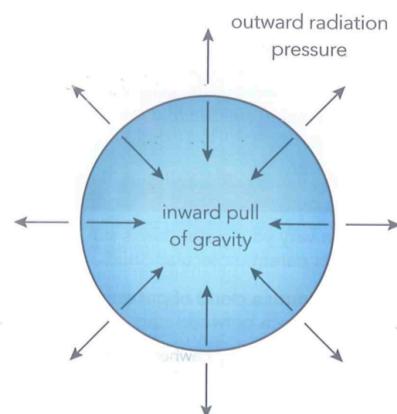


Habitable zone:

Exercise

How long does it take light from the Sun to reach?

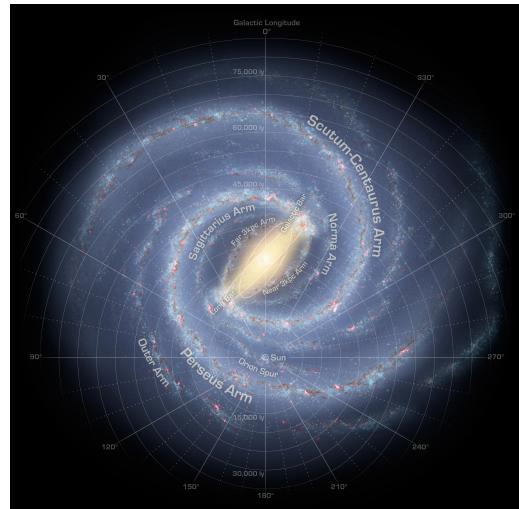
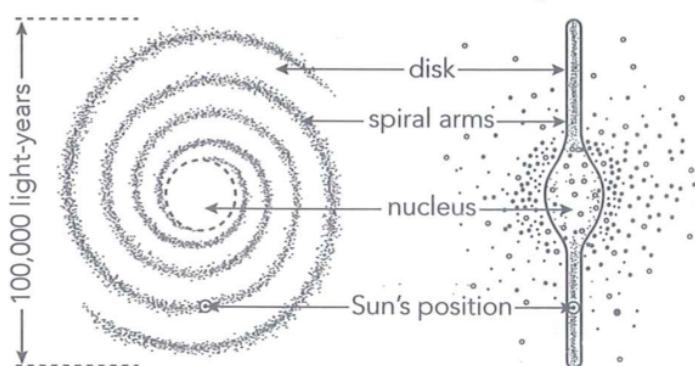
Solar mass:



25.2 Stars and Galaxies

light year:

Galaxies:



Our closest spiral neighbor galaxy:
closest galaxy:

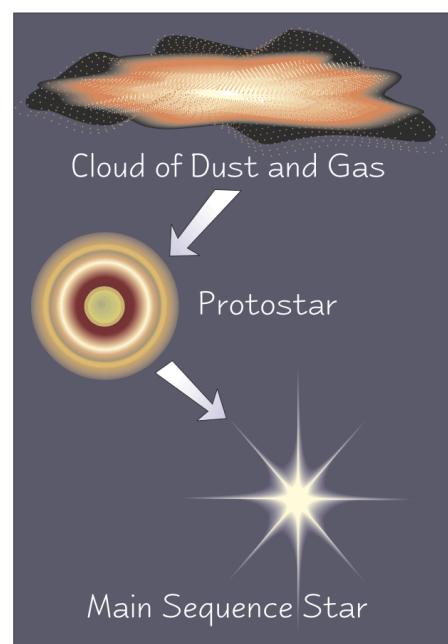
Star Evolution:

protostar

=> **Stable star**(hydrogen fusion begins)

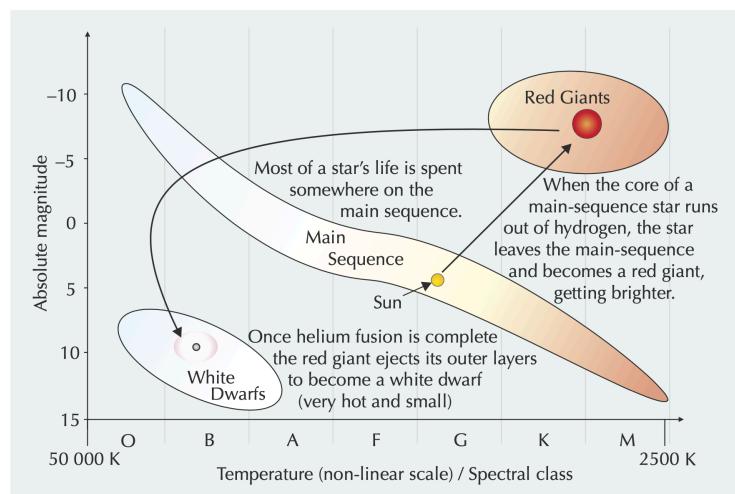
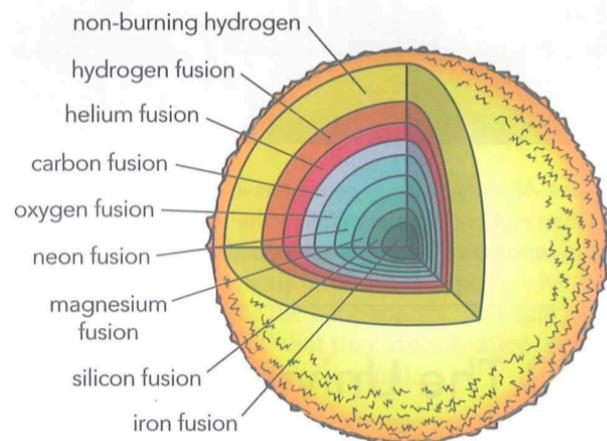


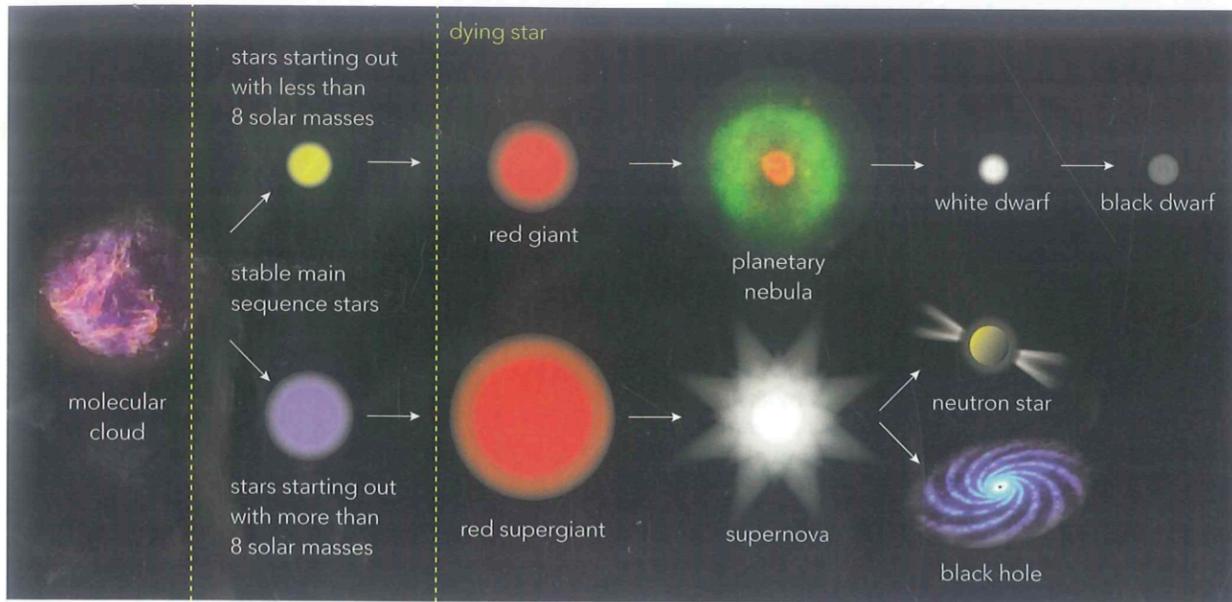
Figure 25.5: The Orion Nebula, the closest region of star formation and visible to the naked eye.



Life cycle of a less massive star like Sun:

Life cycle of a star exceeding 8 solar masses:





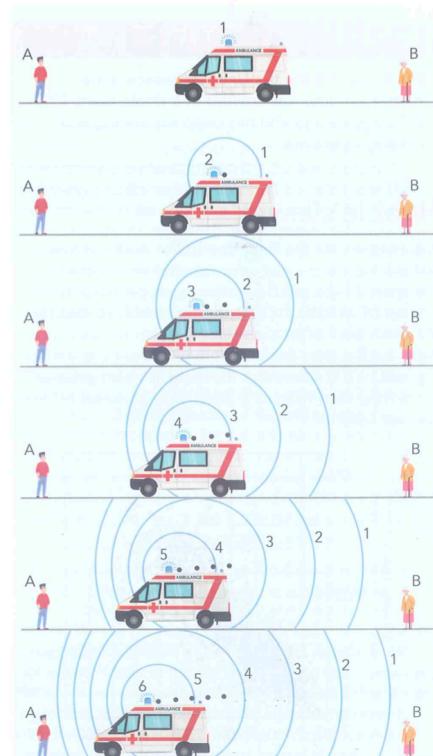
25.3 The Universe

Who discovered universe and when?

The Doppler effect(applies to all waves):

redshift:

blueshift:

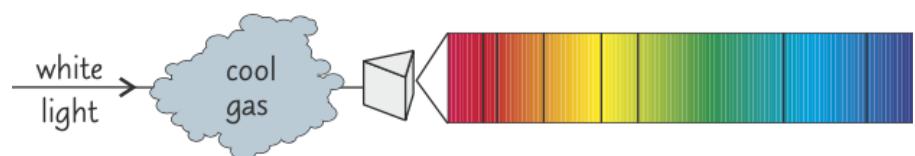
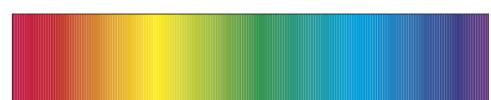


Spectroscopy:

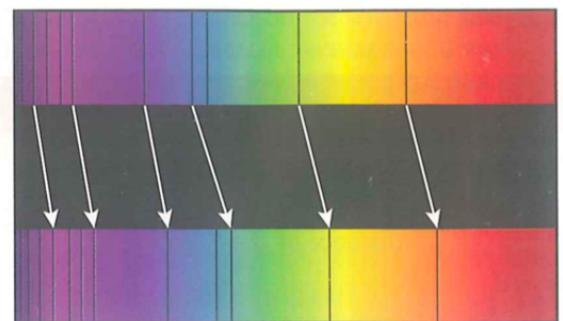
Continuous spectra:

Absorption lines:

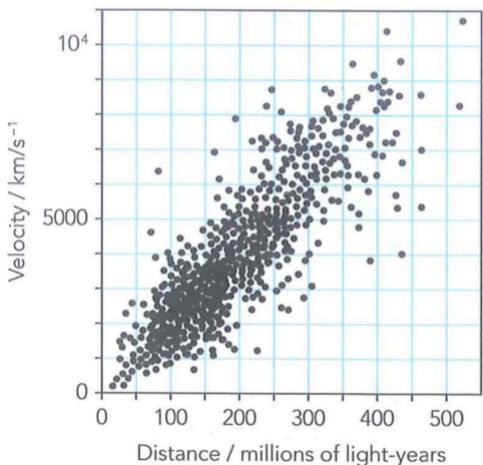
Absorption spectrum:



distant galaxies **redshifted** =>



Hubble observation:



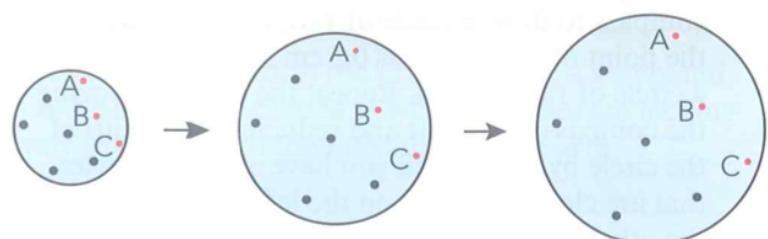
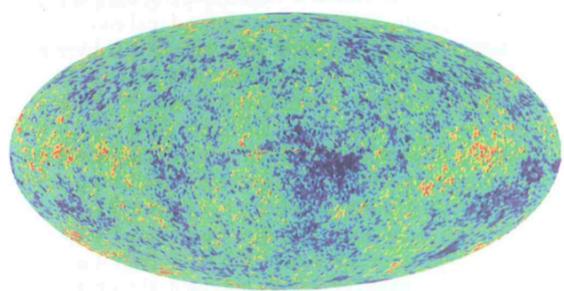
The big bang theory:

Hubble's law:

Exercise:

Estimate the age of universe.

Cosmic Microwave Background Radiation(CMBR)—another evidence of the big bang
Explain CMB:



Measuring distance with **supernovae**(standard candle):

