Stars and Galaxies

There's all sorts of exciting stuff in the Universe... Our whole solar system is just part of a hug
And there are billions upon billions of galaxies. Yep, the Universe is pretty huge...

Stars and solar systems form from clouds of gas and dust

1) Stars form from clouds of gas and dust which spiral in together due to gravitational attraction.

2) Gravity compresses the matter so much that intense heat develops and sets off nuclear fusion reactions. The star then begins emitting light and other radiation.

3) At the same time that the star is forming, other lumps may develop from the same spiralling cloud. These eventually gather together and form planets which orbit around the star.

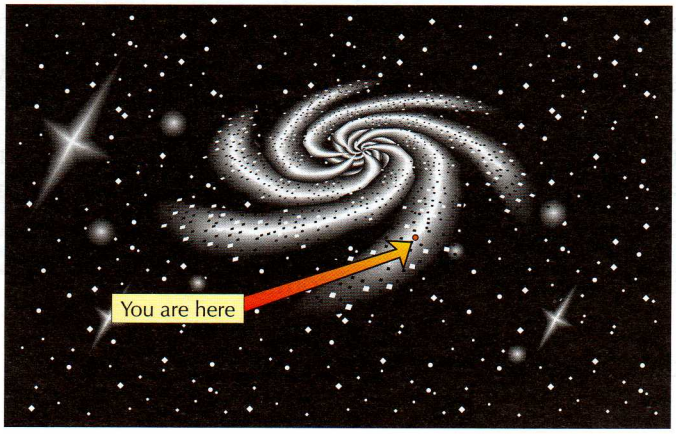
Our Sun is in the Milky Way galaxy

1) The Sun is one of many billions of stars which form the Milky Way galaxy.

2) The distance between neighbouring stars is usually hundreds of thousands of times great than the distance between planets in our Solar System.

3) Gravity is of course the force which keeps the stars together in a galaxy and, like most th in the Universe, the galaxies all rotate, kinda like a Catherine wheel only much slower.

4) Our Sun is about two thirds of the way out towards the end of one of the spiral arms of th Milky Way galaxy.



Stars and Galaxies

The whole universe has billions of galaxies

1) Galaxies themselves are often millions of times further apart than the stars are within a galaxy.
2) The Universe is mostly empty space and is really really big.

The early universe contained only hydrogen

1) At the very beginning, just seconds after the Big Bang, there was only hydrogen (with some helium forming very soon after). As the Universe expanded, these atoms clumped together to form stars.

2) In the cores of stars, hydrogen nuclei smash together to form helium nuclei.
This is nuclear fusion. As a star grows older, all the hydrogen in the core turns into helium.

3) Once the hydrogen has run out, helium nuclei fuse to form other, heavier elements. Three helium nuclei can combine to form one carbon nucleus. More helium nuclei combine with carbon nuclei to make oxygen and neon. This all happens in red giant stars (see p164).

4) Eventually the helium in the core runs out, and some of the carbon, oxygen and neon combine to make silicon. In the very biggest stars, nuclei keep on combining by fusion until they've formed iron.

5) At the end of their lives, massive stars explode, flinging gas out into space. In these explosions, heavy nuclei combine with each other and with neutrons to make pretty much all the elements in the Universe.

6) The dust and gas from these supernova explosions can form new stars and planets (like ours). These second (or third, or fourth...) generation star systems contain heavier elements as well as hydrogen.

The Universe — it's impressive stuff

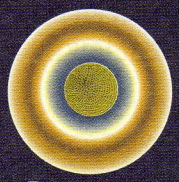
Just look at those numbers: there's billions of stars in the Milky Way, the Universe contains billions of galaxies... And all of the elements in the Universe were made in stars from hydrogen and helium...

The Life Cycle of Stars

Stars go through many traumatic stages in their lives.

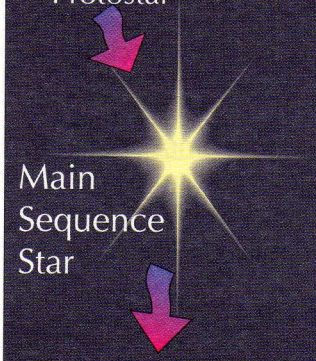
Clouds of Dust and Gas

1) Stars initially form from clouds of DUST and GAS.



Protostar

2) The force of gravity makes the gas clouds come spiralling in. As th gravitational energy is converted into heat energy and the temperat



Main Sequence Star

3) When the temperature gets high enough, hydrogen nuclei unde nuclear fusion to form helium nuclei and give out massive amo heat and light. A star is born. It immediately enters a long stab where the heat created by the nuclear fusion provides an outwa pressure to balance the force of gravity pulling everything inwa In this stable period it's called a MAIN SEQUENCE STAR. Beca the balanced forces stop everything exploding outwards or coll inwards, and because of the huge amount of hydrogen stars co this stable period can last millions of years.
(The Sun is in the middle of its stable period... or to put it anoth the Earth has already had half its innings before the Sun engulfs

Red Giant

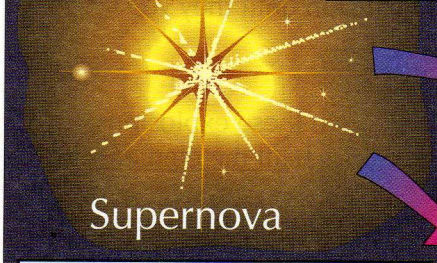
4) Eventually the hydrogen begins to run out and the star then swells into a RED GIANT. It becomes red because the surface cools.

5) A small star like our Sun will then begin to cool and contract into a WHI DWARF and then finally, the light fades completel becomes a BLACK DWA

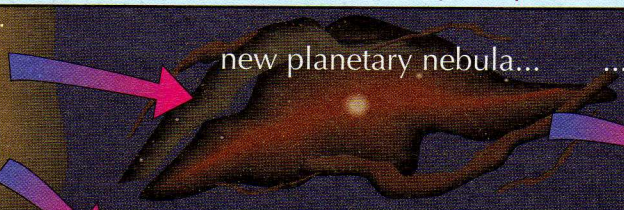
Small stars → White Dwarf → Black

Big stars

6) Big stars, however, start to glow brightly again as they undergo mo and expand and contract several times, forming heavier elements nuclear reactions. Eventually they'll explode in a SUPERNOVA.



Supernova



new planetary nebula...

...and a new solar

Neutron Star...

7) The exploding supernova throws the outer layers of dust and gas into space, leaving a very dense core called a NEUTRON STAR. Or if the star is big enough, a BLACK HOLE.

...or Black Hole

8) The dust and gas thrown off by the supernov form into SECOND GENERATION STARS li Sun. The heavier elements are only made in stages of a big star, many in the supernova i the presence of heavier elements in the Sun inner planets is clear evidence that our beau and wonderful world, with its warm sunsets fresh morning dews, has all formed out of th remains of a grisly old star's last dying sneez

9) The matter from which neutron stars and white dwarfs and black dwarfs are made is MILLIO TIMES DENSER than any matter on Earth because the gravity is so strong it even crushes the

Warm-Up and Exam Questions

Here are some nice warm-up questions to get you into the swing of things before you try the exam questions. If you find any of the questions difficult, take another look back at the section.

Warm-Up Questions

1) What is a galaxy?
2) What are stars formed from?
3) What type of star will form a black hole?
4) At the end of its main sequence state, what does a star become?

Exam Questions

1 Many stars in our galaxy are second generation stars.

(a) What is meant by a second generation star?

(1 mark)

(b) In which galaxy is our Sun?

(1 mark)

(c) What keeps all the stars together in a galaxy?

(1 mark)

2 (a) What was first element present in the Universe seconds after the Big Bang?

(1 mark)

(b) How were most helium nuclei formed in the early Universe?

(1 mark)

3 Stars go through many stages in their lives.

(a) Describe how a star is formed.

(3 marks)

(b) Explain why main sequence stars undergo a stable period that can last millions of years.

(2 marks)

(c) When main sequence stars begin to run out of hydrogen in their core, they swell and become Red Giants.

(i) What happens to small stars after their Red Giant phase?

(2 marks)

(ii) What happens to big stars after their Red Giant phase?

(3 marks)