GCSE Astronomy Topic 4 Key Facts

Seeing the Milky Way

With the naked eye the Milky Way appears as a faint cloud crossing the night sky. With binoculars or a small telescope one can see that it is made up of many thousands of stars

Our galaxy is a disc containing many billions of stars although most are hidden by clouds of dust. What we see is the plane of our own galaxy

The Structure of the Milky Way

The Milky Way is a disc with spiral arms. Its diameter is about 100,000 light years. Our Sun is about 2/3 from the centre. It takes about 250 million years to rotate once.

Open clusters – these are sites where stars are forming, e.g. the Pleiades

Globular clusters – these lie outside the main disc in the halo. They contain very old stars.

Astronomers use 21cm radio waves to explore the structure of the Milky Way. They are emitted by stars and red or blue shifted by certain amounts depending on their relative motion.

The Local Group

Our galaxy, The Milky Way, is one of about 30 in **The Local Group**, a bunch of galaxies relatively close to each other. (including Triangulum, Large and Small Magellanic Clouds and Andromeda)

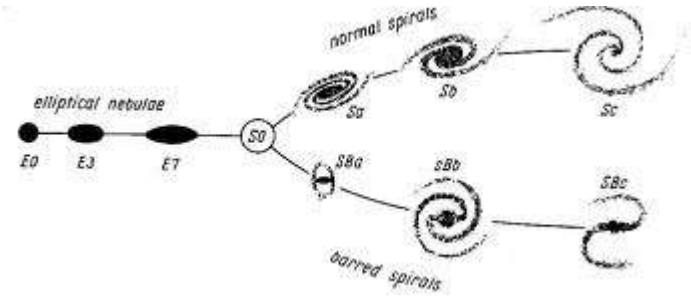
Larger groups of galaxies are called **clusters** and these are grouped in **super clusters**

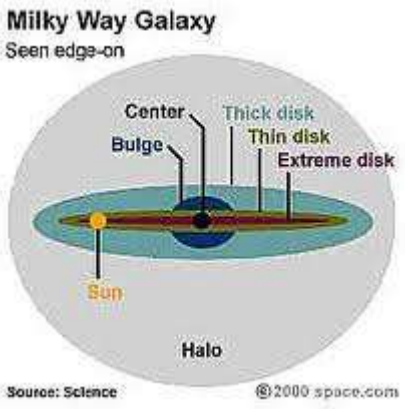
The Universe contains millions of super clusters

Classifying Galaxies

Galaxies may be spiral, spiral barred (ours is a Sb), elliptical or irregular.

Hubble classified galaxies using a tuning fork diagram.





Active Galaxies

Some galaxies emit huge amounts of X rays and radio waves from their nuclei (AGN = active galactic nucleus)

They have massive black holes at their centre. Matter in a disc (accretion disc) spirals around the black hole at very high speeds and this produces the radiation. Some of the matter bounces off before it is sucked in producing jets of matter.

Seyfert galaxies – They are very bright. The light from these comes from excited gas in a cloud surrounding the accretion disc. Radiation from the disc excites it.

Blazers – as they rotate the amount of radiation we detect varies greatly, as it would from a lighthouse.

Quasars – These are very big, very old, very bright galaxies very far away. All we see is the radiation jetting from the nucleus.

As some quasars are very far away they show massive red shifts.

Scientists first thought the regular pulses of radiation from these galaxies may have been evidence of extra terrestrial technology.

Red Shift

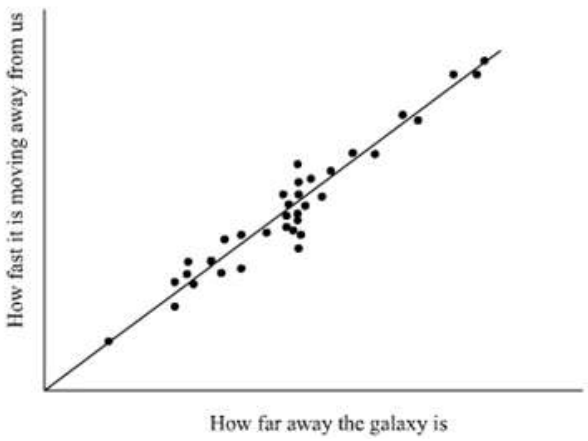
If an object is emitting waves and is moving away from us then the wavelength of these waves is stretched. We call this red shift (as visible light waves are stretched towards the red end of the spectrum)

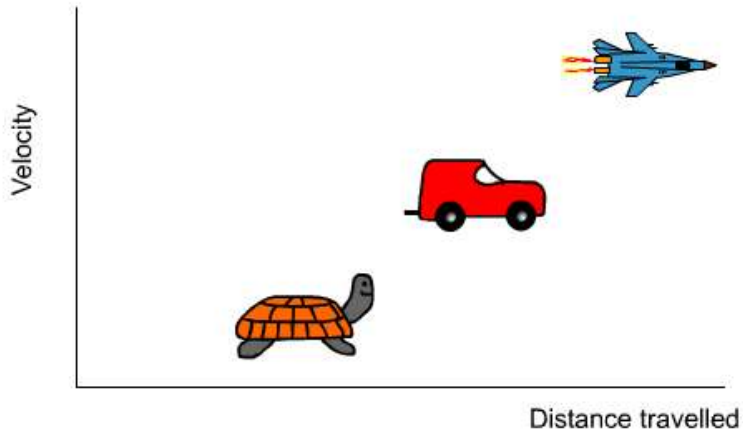
The faster an object is moving the greater the red shift. We can calculate the relative velocity using the equation $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ where λ is the original wavelength, ∆λ is the difference in wavelength, v is the relative velocity and c is the speed of light.

All galaxies (apart from a few in the local group) appear to be moving away from us.

Hubble's law

Edwin Hubble discovered that the recession velocity of a galaxy is proportional to its distance from us. In other words $v = Hd$ where H, the gradient of the graph, is the Hubble constant





This suggests that the Universe is expanding. We can work out from the graph how long it has been expanding for, i.e. the age of the Universe. (about 13.6 billion years)

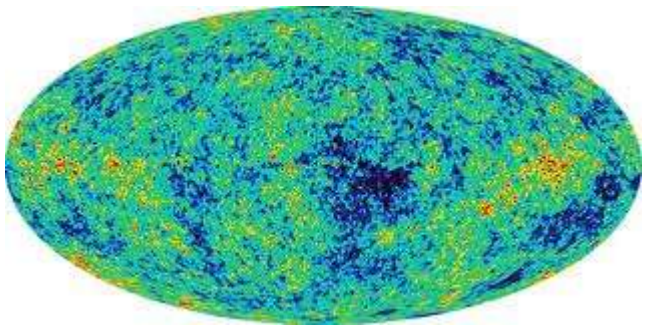
Cosmic Microwave Background radiation (CMBR)

When the Universe was very young and very hot it started emitting radiation, mostly ultra violet.

This radiation has been red shifted and is now detectable, in all directions in the sky, as microwaves.

It was discovered by accident by two telephone engineers.

WMAP is a space probe sent to accurately measure the amount of CMB radiation in all directions and so map the early Universe. It appears that when the radiation was emitted the Universe had already started to clump together.



Dark matter

We can only see things if they emit or reflect light. Most of the Universe doesn't. It is dark to us. We know there is a lot out there because much of the calculated mass of galaxies is not visible.

It may be

- Dark dust and gas
- Black holes
- Particles that we can't see

We know very little about **dark energy** though it has been estimated that 72% of the Universe consists of it. For some reason it causes the expansion of the Universe to be speeding up.

The Expanding Universe

As nearly all the galaxies are moving away from each other scientists agree that the Universe is expanding.

The most popular theory is that the Universe started with a big bang in which a huge amount of energy was converted into matter and space. Space has been expanding since then.

Hubble's observations and the evidence of CMBR support this model though not all scientists agree.

One day, when all stars have used up their fuel, the Universe will be very big, very dark and very cold.