

The Expanding Universe

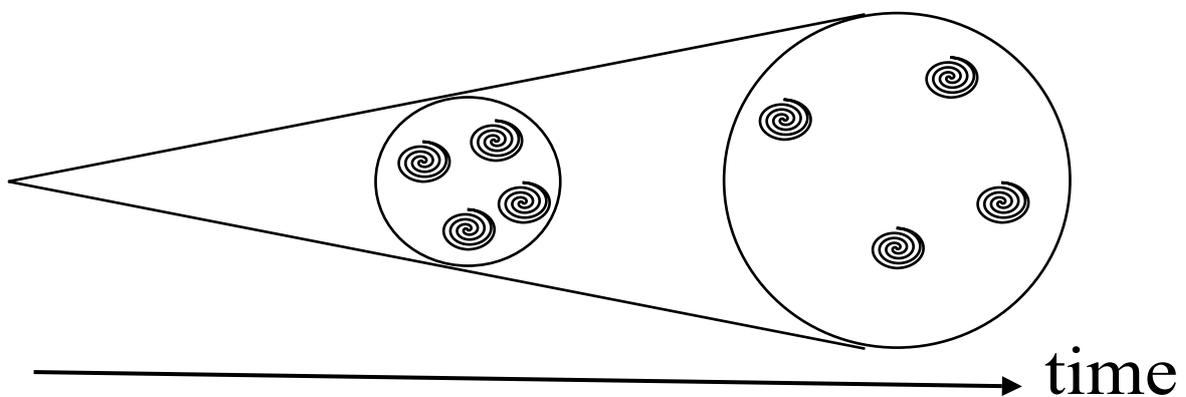
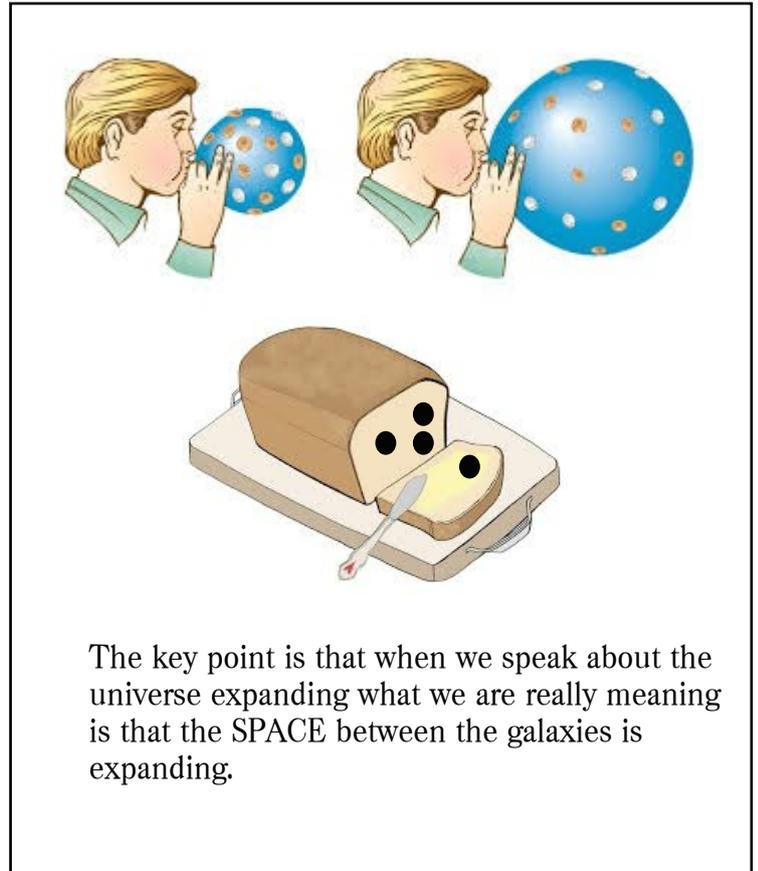
The information from the redshift of galaxies tells us the galaxies are moving away from Earth. Or more precisely space is expanding

You get the idea of the expanding universe by inflating a balloon. Marker pen dots on the balloon move away from each other as the balloon is inflated.

It is really the skin of the balloon that is increasing the distance between the dots. The actual dots are not getting larger.

Another model of the expanding universe is that of baking raisin bread.

As the dough bakes it rises and takes the raisins with it. Each raisin sees the other raisin move away. The individual raisins are not expanding themselves



If the Universe is expanding it must have expanded from something that started the inflation.

This start of the inflation is called THE BIG BANG.

After the Big Bang the Universe started to inflate rapidly.

Starting off like a very hot soup the universe expanded and cooled down.

Using the Hubble Law and assuming that the rate of expansion is constant then the age of the universe is about 14 billion years.

At the beginning matter as we know it did not exist.

Stars and galaxies formed after about 400 million years.

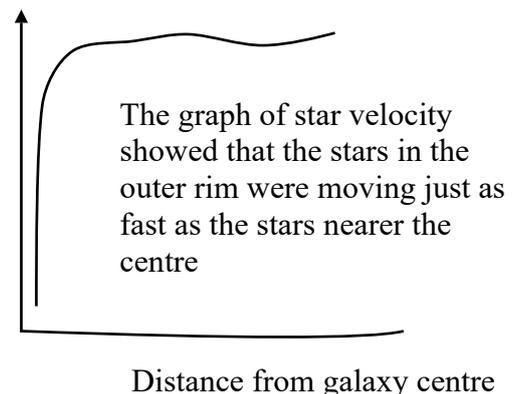
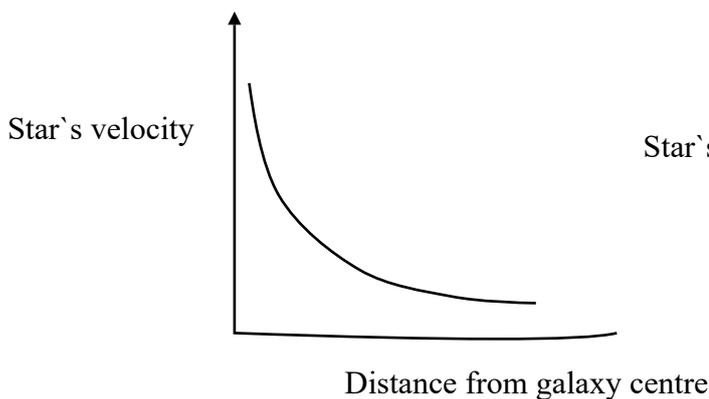
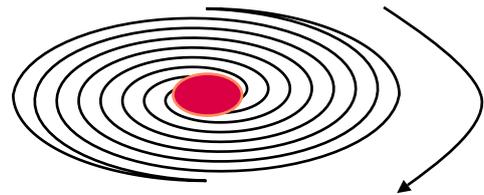
The Expanding Universe **PROBLEM 1**

The faster a father swings his child the more he has to hold onto her to stop her from flying away.

In 1970 an astrophysicist called Vera Rubin measured the rotational speeds of stars in nearby galaxies.

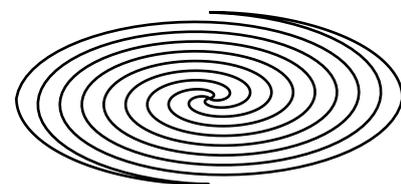
It was expected that stars nearer the centre of the galaxy rotated faster than galaxies at the outer rim because the stars nearest to the centre had to move quicker to stop themselves being pulled in by the gravitational force due to the large mass at the galaxy centre.

This is an example of Newton`s Law of Gravitation.



Vera Rubin`s discovery meant that there had to be more mass than could be seen. Just as the father swinging the child has to pull more on his child`s arms the faster she goes so the pull of gravity had to be larger at the rim than it was to hold the stars from flying away.

The conclusion was that there must be a kind of matter that cannot be seen that accounts for the missing mass needed to provide the extra gravitational attraction to keep the stars in the outer rim bound to the galaxy.



Dark Matter (Transparent matter)

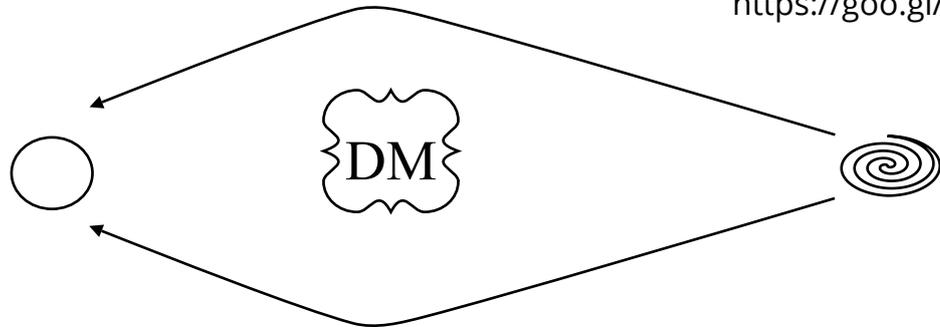
Dark Matter

Dark Matter is invisible. Though invisible it can be detected indirectly by gravitational effects.



<https://goo.gl/jFW>

**Dark Matter
Makes up
24% of the
universe**



The Expanding Universe PROBLEM 2

The universe is expanding. As it expands the rate of expansion should be checked by the pull of gravity of each galaxy.

Astrophysicists by studying super novae conclude that the rate of expansion is actually increasing.

There must be something which is getting the better of gravity.

That something seems to be getting better as the universe is expanding.

Remember it is the space between the galaxies that is expanding.

So that something which is increasing must be linked to the space that is expanding.

That something is called **DARK ENERGY**

**Dark Energy
Makes up
71.4% of the universe**

