U3Astronomy Meeting – 28 November 2008

GALAXIES

Galaxies are huge assemblies of stars, dust, gas – and 'Dark Matter'. We live in the *Milky Way* galaxy, and all the stars we can see in the night sky belong to the MW.
In 1610 Galileo looked at part of the MW through his telescope and he was the first to see it as a massive collection of stars. Until the 1920's astronomers believed the MW to be the only galaxy, but then Hubble discovered that there were more of them. Nowadays it is estimated that there are between 100 and 125 billion galaxies! Hubble developed a classification based on the shape of the galaxies:
Spiral – flattened disc with a ball-shaped hub and stars around this in arms.
Barred spiral – about the same, but with a bar-shaped hub of stars in the centre.
Elliptical – more or less ball-shaped (rugby!), with mainly big, old stars and no 'arms'. All the rest: *Irregular,* in all sorts of forms.
Many have a Black Hole at their centre (= areas of enormously concentrated mass, where the escape velocity is larger than the speed of light). All stars follow a path around the galaxy's centre.
Galaxies vary enormously in size, from some millions to many billions of stars (MW: 500 bn), with diameters of some thousands to over a million of lightyears. (1 Ly = 9.5 trillion km).
Apart from *stars,* galaxies also contain gas (mostly H) and nebulae: 2 types:

1. concentrations of H, where stars are born.
2. debris of dead stars.

Everything is held together by the galaxy's own gravity. Galaxies often are grouped in clusters, and these in super-clusters, etc. And here, again, it is *gravity* which keeps things together.

Origin

The first galaxies were formed in the very beginning of the Univ. as the result of tiny density fluctuations in the Univ.'s matter shortly after the BB.
Until about ten years ago astronomers believed in the *hierarchical model* of galaxy formation: after the BB small galaxies were formed, which merged into bigger ones etc. etc. This is not completely wrong, but recently (Feb.'04) it has been possible – thanks to the fantastic developments in telescopes – to find massive galaxies about 13 bn years old!.
How do we *measure* the distance to far away galaxies? Hubble discovered in the 1920's that the Universe is expanding, and he stated that as a result the wavelengths of light travelling towards us are stretched (*Hubble's Law*). This causes a redshift in the light we receive (*Doppler* effect), and the larger the redshift, the longer the distance the light has travelled.
To *see* as far as 13 bn Ly's is possible thanks to *gravitational lensing:* the gravitational force of massive clusters of galaxies bends the path of light rays, which can make them work as a lens.
The oldest galaxies, discovered in 2004 by using the 10-metre Keck-telescope at Hawaii, were magnified 20 times by such a cluster.

The *Milky Way*

Our 'home galaxy'. The name comes from Greek mythology: The MW is probably a barred spiral galaxy. *'Probably'* , as we can not have a look at the MW from outside!
But there are a number of things of which we are pretty sure:

- Diameter = about 100,000 Ly's and thickness in the centre = about 4,000 Ly's
- The centre is probably a Black Hole containing 3-4 million Solar masses
- Number of stars: about 500 bn
- Total mass of the MW: about 1000 bn times that of the Sun, of which some 90% is DM

The MW started to form some 13 bn years ago in the very young Universe. We (= the Solar System) are situated in one of the spiral arms, at a distance of about 26,000 Ly's from the centre. We orbit the centre of the MW at a speed of c. 220 km/sec, and one orbit takes about 250 mln years.
It is very difficult to *see* the core of the MW because of the thick layers of gas and dust you have to look through. But we can partially observe what happens there with X-rays, infrared and radio waves and gamma rays.

P.T.O.

The 'Local Group'
The MW (also) belongs to a cluster: the 'Local Group', a small collection of about 40 galaxies. The two largest galaxies in this group are *Andromeda* (2.5 x the MW) and the Milky Way. In its turn, the Local Group forms part of a much larger 'super cluster'.
Andromeda is about 2.5 mln Ly's away from us. It is the most distant object that can be seen from Earth by the naked eye. Again, it was Hubble who in 1923 discovered it to be an extra-MW galaxy (the first one!).
Within the Local Group some galaxies move away from us, and others move towards us: Andromeda and the MW approach each other at a speed of 120 km/sec = 4 - 500,000 km/h. In between 2 and 3 bn years from now the two galaxies will collide and after another 3 bn years they will have merged into a massive new, elliptical galaxy. During such a collision, clouds of gas will collide and get hotter, which can lead to the formation of many new stars.

Latest News

Chandrayaan-1
The Indian spacecraft *Chandrayaan-1,* launched on 22/10 towards the Moon, came into orbit around the Moon on 8/11, after a journey that took 2.5 weeks. It carries 11 instruments – more than half of which from other countries – to study the Moon in further detail than was done so far.
Edeavour to the ISS
On 14/11 the shuttle *Endeavour* was launched towards the ISS with a crew of 7 astronauts. Several space walks were carried out during which various tasks were performed successfully. During one of these space walks, one of the astronauts 'lost' a tool bag (worth $ 100,000), which became the latest addition to the fleet of some 9,000 debris objects orbiting the Earth…. *Endeavour* is planned to return to Earth this coming Sunday (30/11).
Recently the ISS 'celebrated' its tenth anniversary, as it was ten years since the first element was launched (from Russia).
End of *Phoenix*-mission
Phoenix landed in the N-Polar region of Mars on 22/5 (by parachute, after a 10-month voyage), where it was hoped to work for some 90 days. It could never much exceed that period (like *Spirit & Opportunity,* now almost 5 years active), as with the approaching winter in the polar region the spacecraft will be covered in thick layers of ice (CO2) which it will probably not survive. On 2/11 there was no contact anymore, as the low Sun did not activate the solar panels anymore. But that means that it worked 2 months longer than planned!
Phoenix studied soil and ice samples from the soil on which it stood, and the $ 475 mln-mission is regarded as a complete success.
Hubble repair mission
At the moment *Hubble* functions again, using the back-up instruments on board which had never worked since the launch in 1995. It looks as if the repair mission to the Telescope will at the earliest take place in May of the coming year. Much work still has to be done to find out exactly what went wrong in September and how these problems can be solved. *And* two shuttles must be available!
Glaciers on *Mars*
The *Mars Reconnaissance Orbiter* recently discovered ice sheets up to half a mile thick in mountain regions on Mars. It is the first time that reserves of water ice that thick have been discovered outside the polar regions. It is encouraging in the search for possible remains of life on Mars.
Exoplanets
Ten *new ES planets* have been discovered over the last six months by using robotic cameras. They look for transits of planets in front of their stars.
The total number of discovered exoplanets (since 1995) is now 312 (Oct).