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'Wonders of the Universe' 1-3
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Cepheid variables

CV's are stars which help us to measure distances in the Universe. The ways in which we measure distances in space – mostly distances from Earth to other celestial bodies – depends on the distance to these objects. As may be expected: the nearer, the more accurate (see also Summary of 04/05/09).
For the Moon, the planets and the nearest stars various pretty accurate methods can be used: laser beams, radar beams, parallax method.
For more distant stars the Cepheid variables can sometimes be used. Most stars shine (more or less) steadily – like our Sun. But the light of a small number of stars varies, and that in an extremely regular fashion. A first example was discovered in 1784 by an astronomer in Yorkshire. In following centuries more of these variable stars were found, but not very many: at the moment some 400 are known.
All of them are yellow super giants with a luminosity on average 10,000 times that of the Sun. They are all stars in the final phase of their lives, running out of their nuclear fuel (H → He).
In the first years of the last century the American astronomer Henrietta Leavitt found the exact periods of 16 Cepheids. Then, in 1912, she discovered the precise relationship between the period and the luminosity of these stars: the longer the period of a Cepheid, the more luminous it is.
That made it possible to calculate the star's distance. This is done on the basis of comparing the luminosity of the star as we know it to be on the basis of the duration of its period, with the brightness as we measure it on Earth. Here we use the physical law that a star's brightness decreases with the square of its distance (for instance: double distance = ¼ brightness).
It is, of course, an indirect method to measure distances, but with the help of space telescopes – like *Hubble* – the method has been refined to variations of not more than 3%.

(Spiral) galaxies

Apart from individual stars (and planets) – all visible as dots in the sky – there are also lots of light emitting clouds or nebulae. Best known is *Andromeda,* our nearest neighbouring galaxy, and the only one of these clouds which is visible to the naked eye. When, however, astronomers started to use telescopes – now just over 400 years ago – many more were found. Important was, for instance, the work of William Herschel and his sister Caroline, who between them found over 2000 nebulae, which they carefully catalogued.
There was, however, little idea in those days – around 1800 – of the exact nature of these vague spots. It was more than a century later that Edwin Hubble discovered that our *Milky Way* is not the only galaxy and that many of the nebulae we see in the sky are also galaxies. Nowadays it is estimated that there are some 125 billion !
Some 75% of all galaxies are beautifully formed spirals – with ball-shaped and bar-shaped centres.
To this day, a completely exhaustive explanation of the spiral form has not yet been found. Many ideas are based on gravitational nudges from neighbouring galaxies that set them spinning.

Globular clusters

Not all light emitting clouds and nebulae are galaxies, however. There are also big, spherical 'balls', 60-300 light years across (= much smaller than galaxies!), containing large numbers of stars, usually between tens of thousands and one million. The first one was discovered in 1655, and Herschel, who 150 years later discovered many of them, was the first to call them *globular clusters.*
When compared to the MW – or any galaxy – these globular clusters are very densely packed: the average distance between the stars is relatively small, as they are tightly bound by gravity.
And within these clusters, the stars – again – follow elliptical orbits around the cluster's centre.

News

400 Years of Galileo's moons

In January 1610 Galileo discovered Jupiter's four largest moons, and in March 1610 – now exactly 400 years ago - he published his famous discovery, which rocked the astronomical world: the Earth was no longer the centre of the Universe.

Now, 400 years later, we know a lot more about these moons. Firstly, that they are not the only ones, but just the biggest: Jupiter has over 60 moons. And the four *Galilean* moons are very different, despite all having formed in the same place and about the same time:

Callisto is one of the most heavily cratered bodies in the Solar System

Io is the least cratered and the most volcanically active (over 400m volcanoes)

Europa probably contains the largest ocean of water below its icy surface (life ?!)

Ganymede, the biggest moon in the SS, is the only one of the four with a magnetic field.

Soyuz - Discovery– International Space Station

On 18/03 a Soyuz spacecraft brought home two astronauts who had been working at the ISS for 6 months. The Soyuz landed safely, on a huge parachute, in the wintry landscape of Kazachstan.

The Shuttle *Discovery* is planned to be launched towards ISS on 5/4 for 2-week mission. This will be the last shuttle-flight but 3 ! But NASA is (again) contemplating an extension of the Shuttle program. President Obama recently cancelled the *Constellation* program for the Shuttle's successor.

It has now been decided that on 15/4 a Space Conference will be held in Florida - with President Obama - about NASA's future.

In the meantime, leaders of the the ISS-partners (USA, Europe, Russia, Japan and Canada) met in Tokyo two weeks ago, where it was decided to extend the life of the ISS at least to 2020 and possibly to 2028 (30 years after the Russians launched the first component of the station)

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Chinese plans

China recently published some of its plans for the near future: In October it will launch its second Moon orbiter, with high-resolution cameras (objects visible of less than 1 metre diameter!). It will map possible landing sites for robotic spacecraft. And next year China hopes to launch a modest space station.

More water on the Moon

Last year the results of the LRO (+LCROSS) mission to find water in the Moon's polar regions were somewhat disappointing. Now it has been confirmed, that similar (NASA) instruments on board of India's *Chandrayaan* have found much larger quantities of water-ice in other polar craters (where sunlight never reaches the bottom). The total amount has been estimated at 600 million tonnes.

Shock effect on Earth's axis

The heavy earthquake that struck Chile some weeks ago may have shifted the Earth's axis and slightly increased the rate at which the planet rotates. This resulted in shorter days, 1.26 microseconds shorter, to be exact. The same happened with the heavier earthquake near Sumatra that caused the tsunami disaster on Boxing Day 2004, when the days got 6.8 microseconds shorter.

Search for extra-terrestrial life

When looking for life elsewhere in the Universe it is important not only to concentrate on extra-terrestrial places, but also on Earth! The fact that life started on Earth very soon after the Solar System had been formed (4.5 vs, 4 bn years ago) gives the impression that starting life wasn't a really big issue. But so far nobody has been able to understand how it actually happened, and it is generally seen as the result of a miraculous combination of factors, which makes it highly improbable that it happened more than once.

But recently new light was shed on this problem. We have always supposed that life started one time in one place on Earth. But imagine that life started twice, or perhaps even more times, in different places and at different moments – and then perhaps developed into strange forms of life which we simply don't recognize. If that were the case, starting life must not have been such a miraculous event.

So the idea is that if we can find proof that life began several times on Earth, we can be pretty sure that other Earth-like planets are also teeming with life!