The Tenth Planet - Is it Out There?

In July last year a team of astronomers announced the discovery of the Tenth Planet. It hardly caused a storm in the world media. Why? Because it wasn't the tenth planet at all.

The Tenth Planet. Planet X. It's exercised the minds of astronomers for the better part of a century. But what is it? Where is it? Is it there at all? And best of all - does it really need to be there?

If we go back to the early years of the twentieth century when the search really started, Planet X wasn't the tenth planet at all - it was the ninth. But to really understand what it's all about, we have to go much further back - back to the very beginning of our understanding of the solar system.

Until the early years of the seventeenth century, the solar system was much smaller than it is now. Or of course we should strictly say the known solar system, because we may never know exactly what's out there. There was the Earth, of course, and the Sun and Moon, but the only other members were those that could be seen - Mercury, Venus, Mars, Jupiter and Saturn.

Until the mid sixteenth century, the construction of the solar system was still very much based on the old Greek ideas of Aristotle and Ptolemy. The Earth lay at the centre of the system, and everything else revolved around it. The basis for this didn't just reflect the importance of the Earth. Everyone knew, of course, that if you threw something up in the air, it fell back. How could that happen if the Earth was not at the centre of everything? The concept of gravity was still over a hundred years away. Moreover, everything was fixed. The planets and Sun were physically linked to each other with the stars, again, in a fixed sphere surrounding everything. This, in its turn, was linked to the idea of a physical relationship between heaven and earth, between the stars and planets and the earth, and that events in the skies influenced events here on Earth. This wasn't just religion - it was astrology, which had become almost a religion in itself.

Now during the sixteenth century, astronomers and mathematicians were examining the work of the Greeks, updating it and making corrections, but it was Nicholas Copernicus who started the process of almost literally turning the world on its head. The big problem with the Earth centred solar system was that it couldn't easily explain retrograde motion, that is when a planet appears to stop, turn round and head in the opposite direction. If the Earth is at the centre of everything, it can't happen without the other planets having some fairly strange motions. Copernicus thought that the solar system was not Earth centred but Sun centred. Even with the circular orbits that were the best that could be done at the time, this explained a lot, and because of the circular orbits he proposed a multiple motion for the Earth. For the first time the Earth rotated. But his theories weren't published until after his death in 1543. One reason for this could have been that the western world was dominated by the Catholic church, and to the Catholic church the idea of anything other than the Earth being at the centre of the entire universe was heresy.

However, although the Copernican Sun centred, or heliocentric, system explained some anomalies, it left a lot more questions. Bear in mind that this really was revolutionary thinking. It was inevitable that the first man to propose it, especially with no proof, was going to have a rough ride, and perhaps this was also why Copernicus didn't go public in his own lifetime. In fact it was so radical than the Copernican model was largely just ignored. But there were some cautious converts, and one of these was Tycho Brahe, who modified the Copernican model such that the Earth was still at the centre with the Sun and Moon revolving around it, while everything else went round the Sun. However odd this seems to us now, it pleased everyone and enabled more to embrace the idea that the Earth might not be the centre of absolutely everything. And bear in mind - how odd would what we now know seem to Brahe, Copernicus and their contemporaries? Brahe's model, of course, gave the Moon non planetary status for the first time. Kepler was later to call it a satellite, literally meaning attendant, and a term very much in use

today. In the 1570s Brahe observed both a supernova and a comet, and his observations made it very clear that not only did comets move through the solar system - something not possible if everything is fixed - but that the heavens are not unchanging. Both these concepts were fundamental to the Aristotle system and with Brahe's observations the ideas held for so long were on their way out.

At the beginning of the seventeenth century two things happened. Galileo Galilei is credited with inventing the telescope, but the truth is that probably a number of people more or less simultaneously put two of the new spectacle lenses one in front of the other and discovered they could peer into their neighbours' business. Galileo, however, turned his lenses upwards, and after studying the Moon, discovered what we call the four Galilean moons of Jupiter. Previously Copernican astronomers had wondered why the Earth alone should have a moon, and now the Earth was no longer unique. Moreover, Jupiter and its four moons were a solar system in miniature, proving that things could revolve around a body other than the Earth or Sun. He also observed that Venus, just like the Moon, has phases, and this is only possible if the planet is between the Earth and the Sun. It did not prove beyond reasonable doubt that Copernicus was right, but the Sun centred solar system was gathering credence, although still not with the Catholic church. The full weight of the Inquisition was brought to bear on Galileo and he ended his days under house arrest, though possibly not for this alone.

At about the same time as Galileo was studying Jupiter's moons, Johannes Kepler published what was to become the first of his three laws of planetary motion. Kepler had worked with Brahe studying the orbit of Mars. Brahe had amassed a huge amount of positional data as part of his studies and Kepler was able to use this data and check it with his own observations. What he discovered was that the orbit of Mars was not circular at all. It was elliptical, and moreover it was an ellipse with the Sun as one of its focii. He went on to study the orbits of other planets and found that they too obeyed the same rule.

Kepler's third law concerned the relationship between a planet's orbital period and the size of the ellipse. This too held good for all the planets. It also started a lot of people asking - why? Why the elliptical orbit? Is there something out there forcing the planets into that orbit? Of course there is and it's called gravity. Again, if Isaac Newton hadn't come up with the idea, someone else would have done at around the same time. He actually came up with his theories around 1665 when Cambridge University was closed by the plague, but didn't publish until years afterwards. But he did talk about his ideas and men like Hooke and Halley consulted with him, finally persuading him to publish. Applied to comets, Kepler's and Newton's laws enabled Halley to predict the return of a periodic comet in 1758. Kepler was a Protestant, in fact a Lutheran, but even he wasn't immune from the attentions of the Church. He was excommunicated because he was unable to embrace the link between 'matter and spirit'- looked at another way, heaven and earth - which was fundamental to Lutheran orthodoxy.

In 1781 William Herschel discovered the planet Uranus, observing it as a disk. But had he discovered a planet or a comet? Observations went off to the mathematicians, who proved it to be a planet. Around the same time it was noticed that the mean planet - Sun distance of all the known planets, taking the Earth - Sun distance as one astronomical unit, had a mathematical relationship which Uranus fitted, but there was a gap between Mars and Jupiter where there should have been a planet. But there wasn't, until in 1801 a search turned up the asteroid Ceres. Interestingly, the discoverer only got three uncorroborated sightings before he fell ill and the asteroid was lost behind the Sun, but a new method was able to predict the orbit from just those three sightings. Ceres was subsequently reacquired and the method is still used today. And of course now we know that Ceres is not alone, and that between Mars and Jupiter lies a band of asteroids that may be debris that for some reason never coalesced into a planet, or are the remains of a destroyed planet.

So the solar system, so unchanged for centuries, was growing, and was about to grow again.

After the discovery of Uranus, studies were made of its orbit, and by the early nineteenth century it was all getting a bit disturbing. The orbit was not exactly as it should have been. There were two possible explanations for this. Either the laws of Kepler and Newton broke down over distance, or .....

There was something else out there.

The German astronomer Galle discovered it in 1846 at Royal Observatory in Berlin, within 30 minutes of beginning the search - so good was the prediction of its position. However it had been seen before - by such people as Galileo and John Herschel among others, but they hadn't recognized it for what it was. Two people, John Adams and Urbain le Verrier, had independently predicted the new planet Neptune's position - the first time gravitational laws had been turned round and used to find something purely from its effect on something else - but they were lucky. The predicted position only held good for a period of about three years after the discovery. Guess what - Neptune's orbit didn't behave as it should either, and this is when the real search for Planet X begins.

In 1905 Percival Lowell - he of the Martians canals fame - completed a study of the orbit of Uranus. Uranus because its orbit was better known than that of Neptune. Neptune will not complete its first full orbit since discovery until 2011. Based on that study, he predicted a position for a possible planet, which he called Planet X. It was searched for by a new technology - photography - at Lowell's own Flagstaff Observatory. Nothing was found. Lowell redid his analysis and another search was conducted about ten years later. Something turned up, but it wasn't recognised as a new body. It was too small and too faint. Lowell died with his Planet X undiscovered.

Clyde Tombaugh joined Flagstaff in 1929, tasked with finding Planet X. He used another new technique - that of comparing two photographic plates of the same area of sky to find the object that moves, and in February 1930 Pluto turned up. Planet X was found.....

Or was it?

Interestingly, when Lowell's data was reviewed, it was discovered that he could not have used it to predict the position where Pluto was subsequently found. Another problem, of course, lay in Pluto's size. It was soon found to have a moon, Charon, which enabled Pluto's size to be determined at 0.002 Earth masses. To have the effect on the orbits of Uranus and Neptune that it appeared to have, the new planet needed to be at least 7 Earth masses. In reality Pluto and Charon are almost certainly asteroids. Lowell's biggest disappointment was that he died without finding Planet X, but he would probably have been more disappointed by finding out that Pluto wasn't it.

So the hunt went on.....

And then in July last year they found Xena.

There have been other objects found. Tombaugh himself discovered nearly 800 new asteroids in his fruitless hunt for something bigger than Pluto. There are two major sources of debris around the solar system. One is the Oort Cloud, the source of long period comets. The second is the Kuiper Belt, much closer than the Oort Cloud but still beyond the orbit of Neptune. It is generally accepted that Xena, along with Sedna, discovered in 2004, and Pluto, are Kuiper Belt Objects. A sky survey using an automated version of the technique used by Tombaugh to discover Pluto has been running since 2001 and has turned up 80 Kuiper Belt Objects or KBOs. So there is a lot more out there to find, but do any qualify as true planets? And where does that leave Planet X, apparently happily perturbing the orbits of planets suddenly seeming quite close to home? Well, I asked the question at the beginning does it really need to be there at all, and it seems that maybe it doesn't.

Sedna, discovered by Michael Brown, one of the co-discoverers of Xena, lies twice as far from the Sun as Pluto and is one quarter of the size. Its claim to be the tenth planet was swiftly dismissed, but does Xena deserve the title?

Xena was discovered by Brown, Chad Trujillo and David Rabinovitz using a 1.2 m telescope at Palomar Observatory. Designated 2003UB313, it was first seen photographically in October 2003 but is so far away that it was over a year before movement was detected. The orbit of 2003UB313 is 44 deg above the ecliptic, an area not normally surveyed. It is in a highly elliptical orbit, varying from 97 to 36 AU and coming within the orbit of Pluto at its closest.

The infra red spectrograph on the Gemini North telescope on Mauna Kea indicates methane ice, putting Xena in the same class as Pluto and Neptune's moon Triton, itself larger than Pluto. That being so, Xena's reflectivity should be similar to Pluto's, that is about 60%. That makes Xena about one and a half times the size of Pluto. It has even been found to have a moon, named Gabrielle after Xena the Warrior Princess' sidekick in the TV series, and this will enable a more accurate estimate of mass to be made. But is it, or should it be, a planet?

Xena is almost certainly just a large KBO, the largest found to date, but it is estimated that there may be in the region of 1000 KBOs larger than Pluto and some as large as Mars. But given the distance that a Mars sized KBO must be from the Sun for it to still lie undiscovered, it's unlikely to have any effect on Uranus and Neptune. And it doesn't need to. The Voyager spacecraft missions have furnished new data on the masses of Uranus and Neptune, and when these are used their predicted orbits are as they should be. As further proof, the Voyager and Pioneer craft were studied as they passed through and out of the solar system to determine if anything other than predicted planetary forces were acting on them. Nothing was.

All rather an anticlimax as far as the hunt for the tenth planet is concerned, however....

A team comprising Eamonn Ansboro of the Kingsland Observatory at Roscommon and the Planetary Space Science Research Institute believe that beyond the Kuiper Belt either a Jupiter sized object or a red dwarf star is causing a clustering of cometary orbits.

So maybe Planet X is out there after all, just not where Lowell expected it to be.

And lastly - just what is a planet? The Oxford dictionary defines it as 'a celestial body moving

in an elliptical orbit around a star'. Well that covers a wealth of objects in our own solar system - planets, asteroids and comets to name but some - in fact everything except moons. We refer to newly forming planets as planetesimals and asteroids as minor planets, and up till now the definition seems to have worked on size, but if there are KBOs out there as big as Mars.....

Our solar system might have to grow from six planets in 1780 to several hundred in years to come, that's if we ever invent the technology to find them. Perhaps the Hubble Space Telescope's great, great grandson will stand on Xena.....

But as a footnote, Xena has been seen. It was spotted visually by observers at the Otto Struve Telescope, which is 82" or 2.1m, on October 9th last year. If you want to go out and look for it, it's 19th magnitude. Since to see it through the 2.1m telescope took a lot of averted vision, and I don't think many of those looking for it actually managed to see it, I would advise that a heathy dose of averted imagination should do the trick.