Main Event: Comets by Paul Jenkins

Most people realise that comets come from the Oort Cloud, a huge ball of objects surrounding the solar system but which has a bias of objects towards the plane of the solar system. Interestingly, the two Voyager spacecraft have now been travelling away from us for 40 years. Voyager 1 is 20.6 billion km away but hasn't yet reached the inner edge of the Oort Cloud (1) and will have to continue its journey for another 250 years to do so.
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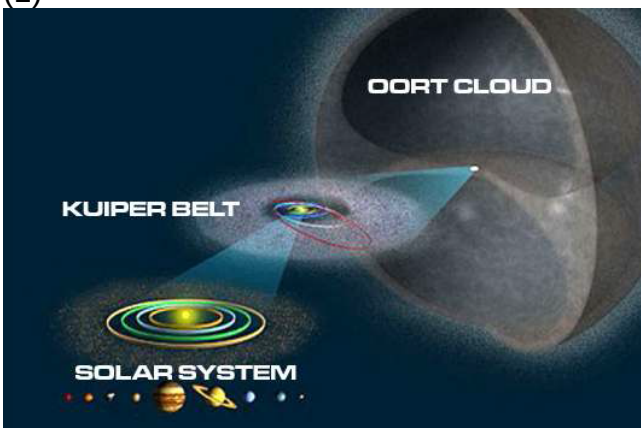

Comets can be described as dirty snowballs; they contain water ice, dry ice, dust, rocks and organic compounds (2). These are quite complex components so where did they come from? The atoms would have existed as part of the cloud of gas and dust that condensed to form our Sun and solar system five billion years ago. This is because our Sun was preceded by other generations of stars that formed heavier elements and then hurled them into space as they died.
(2)

Our Sun comprises 99.9% of the mass of the solar system; the remaining 0.1% was left over to form the planets, asteroids and comets.
Proto-planetary discs can be observed around stars within the Great Orion Nebula and the dust from which these discs are composed will one day turn into planets and yes, comets.

Once comets are disturbed in either the Oort Cloud (where there are over one hundred billion comets) or the Kuiper Belt, they are drawn in towards the Sun, and while many will swing around the Sun, a few will actually hit it. Some comets leave the solar system never to be seen again whereas others will orbit the Sun in a regular way.
Short period comets return to our solar system within 200 years and with orbits that are less than 30° above or below the plane of the solar system. They are thought to originate in the Kuiper Belt.
Over 100 short period comets are known and include Halley's comet (3) that returns approximately every 75 years and was last seen in 1986. Comets are usually named after their discoverer and have a designation that includes letters e.g. P for periodic C for non-periodic, D for disappeared or X for those with orbits that couldn't be calculated.
(3)

Long period comets (4) return in a timescale greater than 200 years with orbits that can be more than 30° above or below the plane of the solar system. Some and probably come from the inner Oort Cloud but periods of over a 1000 years or more suggests they are definitely Oort Cloud objects; Comet McNaught has a period of about 93,000 years, Comet Hale-Bopp 2,500 years – it originally had a longer orbit but when we saw it in 1996, it passed so close to Jupiter that the orbit was shortened.

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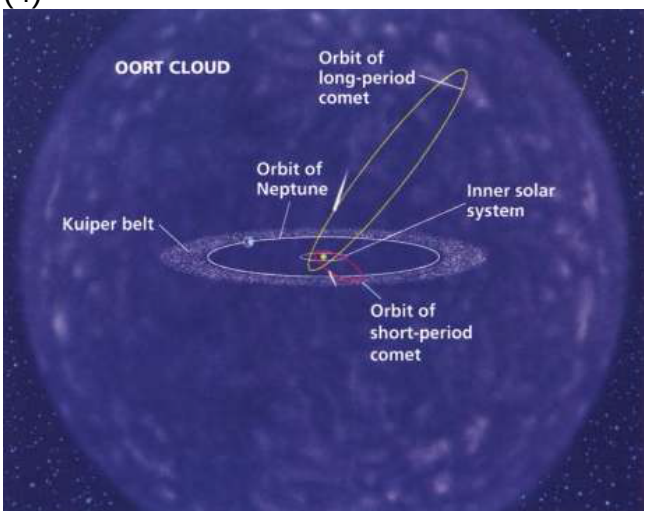

Comets can be spectacular or rather underwhelming and appear more like a fuzzy blob but are always satisfying to spot. Comets have two tails. An ion tail consists of ionised particles that react to the solar wind and always point in a straight line away from the Sun. The dust tail broadly follows the path of the comet and therefore has a curved appearance. (5)
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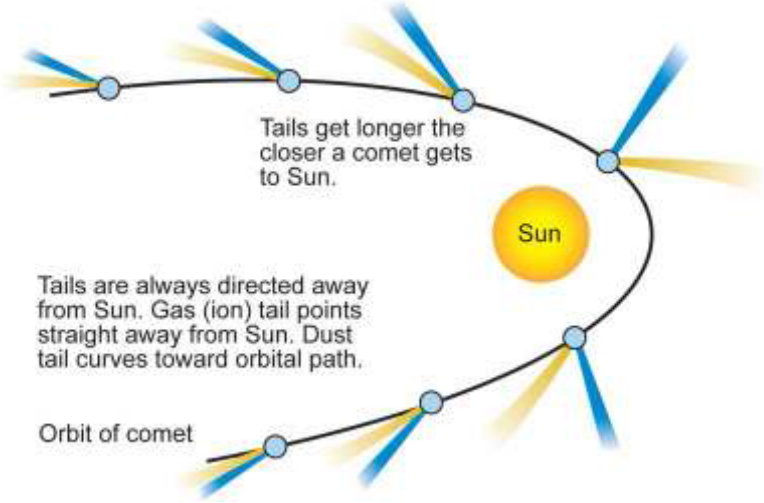

Heat from the Sun cause sublimation of the ices within the comet and with every outburst, dust is released to add to the growing tail. A comet's brightness is unpredictable but photographing them makes a huge difference.
Meteor showers are a by-product of comets. If the comet sheds its dust where the Earth can intercept it during its orbit around the Sun, we will see a meteor shower at the same time every year. Comet 2P/Encke is a good example. It has a period of only 3.3 years and has lost much of its mass during its frequent orbits around the Sun. Every time the Earth passes through its stream of dust, we see the Taurids in late October and early November. (6)

(6)


We know a lot more about comets since visiting them with robotic probes over the last few years. The first mission was called ICE (the International Cometary Explorer). Paul admitted it was a female satellite as it was capable of complicated multi-tasking... Launched in 1978 ICE spent time is various places taking measurements of the solar wind, Earth's magnetosphere and then it was put into a heliocentric orbit to intercept comet Giacobini-Zinner and managed to pass within 7,800 km of the nucleus. (7)

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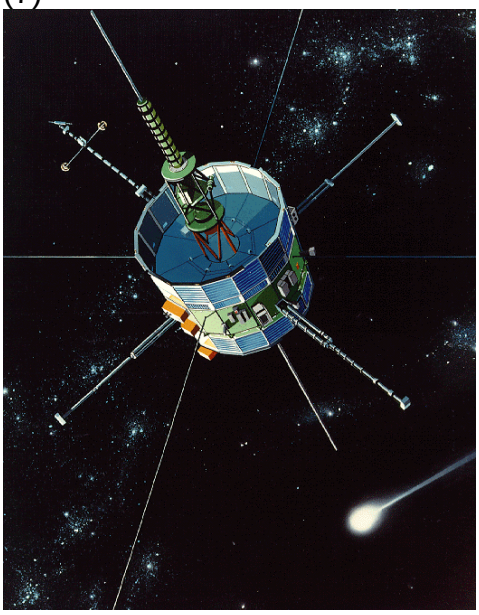
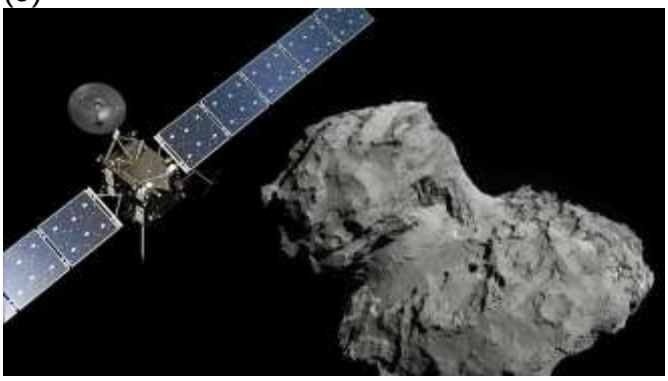


Another successful mission was Deep Impact, launched in 2005 and reaching comet 9P/Tempel just a few months later. Five days before it passed the comet, a washing machine sized impactor was released to crash into the surface of the comet. The main spacecraft filmed the impact and took measurements of the ejecta. It found less than expected water and carbon dioxide ices, and more dust with grains the size of talcum powder. The overall structure was found to be 75% empty space – described as fluffy. (8)

(8)

Perhaps the most well-known cometary mission was the recent Rosetta spacecraft visiting 67P/Churyumov-Gerasimenko, launched in 2004 and arriving in 2014. Rosetta was put into orbit around 67P for 17 months taking amazing photographs and obtaining many measurements. This was a remarkable feat as the gravity varied depending on where the spacecraft was, requiring constant adjustments.
(9)



The high point of the mission was the launch of the lander Philae, which took seven hours to descend. Harpoons were supposed to fire as it touched down, to attach it to the surface as escape velocity was so low, but unfortunately this did not happen due to the surface being so soft. Little Philae bounced twice and slid until it ended up lodged against a cliff out of sunlight so its batteries could not be charged. However, Philae did detect organic compounds. At the end of its life, Rosetta was deliberately crashed (gently) into the comet.
It is important to note that any comet coming close to Earth is not aiming for us – but heading for the Sun. Unfortunately, Earth sometimes gets in the way. Any kind of large impact would cause a problem. Therefore keeping track of solar system bodies is wise. Professional and amateur astronomers hunt down and track comets (Denis, one of our members, is heavily involved in doing this). Near-Earth Objects (NEOs) (10) are also searched for and catalogued. Wide areas of space are scanned close to Earth's orbit looking for objects that are moving and predicting their paths. The information is then coordinated at NASA.
Since 1998 NASA has had a congressional mandate to catalogue all NEOs that are at least 1 km wide as the impact of such an object would be globally catastrophic. Over 900 have been found but there are probably still many smaller ones out there. On the 12th October this year, asteroid TC4 (20 m long and weighing 8,000 tonnes) passed within 43,700 km of the Earth (much less than the distance to the Moon). A near miss?

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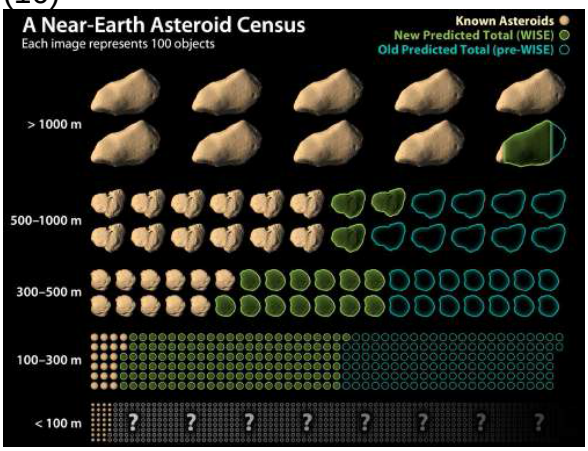

What can we do about an object on a collision course with Earth? It depends on whether it is an asteroid or comet as they are made up differently; asteroids tend to be more solid and are made of rock and metal whereas comets contain more empty space and consist of ice and rocky particles.

Fortunately, the chances of a comet colliding with the Earth are extremely remote so this was a good note to finish on but Paul also reflects on the fact they are beautiful if slightly scary objects, relics from the formation of our solar system that lurk in its cold, distance reaches, until they decide to pay us a visit...