Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Ceres - dwarf planet or very big asteroid.*

Ceres has had an interesting history, with respect to celestial taxonomy. For nearly 50 years it was a planet, then it became an asteroid and then it joined Pluto – which was a planet for a whole 76 years – to become a dwarf planet.

And why is Ceres a dwarf planet? Well, it goes around the Sun, it's round and, being in the asteroid belt – it hasn't cleared it's orbit. At least this planet decision didn't raise a lot of protest, since in our perception of celestial hierarchies, it seems it's better to be a dwarf planet than just a plain old asteroid.

Indeed since Ceres is substantially bigger than any other asteroid it's unlikely to ever have to share the asteroid belt with any other dwarf planets – while Pluto has to share the Kuiper belt with Eris, Makemake and Haumea, with the risk of even more dwarf planets being identified in the future.

Anyway, the history behind how Ceres was once considered to be a planet planet arises from, the now largely debunked, Bode's Law, which was mentioned in a several publications in the eighteenth century, including a publication by Johann Bode in 1772, who then kind of took ownership for the idea.

Bode's law had it that, with respect to the known planets at that time: "…supposing the distance of the Earth from the Sun to be divided into ten equal Parts, of these the distance of Mercury will be about four, of Venus seven, of Mars fifteen, of Jupiter fifty two, and that of Saturn ninety five." Or to put it another way, you always start with four then add 0, 3, 6, 12, 24, 48… each time doubling the number – where the units are a tenth of an Astronomical Unit (AU). So, for example, Earth is 4 plus 6 – that is 10 tenths of an AU – or 1 AU.

This was regarded as an interesting oddity about the visible planets until the discovery of Uranus in 1781 at around the 180 mark by the above scale – which was exactly where the Bode law predicted the next planet out from Saturn should be. This led people to then question why there was a strange gap around the 28 mark – between Mars at fifteen and Jupiter at fifty two. Just as a coordinated search for this apparently missing planet was to commence, Giuseppe Piazzi, who was looking for something else at the time, kind of stumbled across Ceres and announced its discovery in 1801, at just the right orbit that had been predicted by Bode's Law.

From there, Bode's Law enjoyed a long period of legitimacy until the discovery of Neptune in 1846 – which really doesn't fit the law at all – and then Pluto's discovery in 1930 raised even further doubts since it doesn't fit either.

There's still discussion amongst astronomers in idle moments – about whether the remarkable fit of the seven inner most planets and Ceres with the predictions of Bode's Law means something – orbital resonance maybe, some kind of inevitability in the way gas clouds collapse down into planetary disks?

But, by and large, it's mostly considered to be just a coincidence. Here in 2010, we can anticipate a whole new body of data coming in on extrasolar planets – which will enable us to determine if any such relationship exists around other stars – but, it probably doesn't.

Anyway, whatever else it might be, Ceres is a right whopper of an asteroid. It's thought to represent around 30% of the mass of the entire asteroid belt – with a diameter of 950 kilometres, which is nearly double that of the next biggest ones, being Vesta and Pallas. But to put all that in perspective, Ceres has only four per cent of the mass of the Moon and less than a third of its diameter.

Now, that gives some indication that Ceres has a lower density than the Moon – which suggests that Ceres does have volatiles, but perhaps not in the form of a significant atmosphere. Current thinking is that it is composed of a rocky core – with a relatively think mantle of ice – and maybe, just maybe, there might be some amount of liquid water below the icy crust.

This of course makes it a potential candidate for little swimmy things, but we've not got close enough to it to observe for any clear evidence of it having liquid water – evidence like the cracks seen in Europa's icy surface – or the water geysers observed from Enceladus. Also, there's no obvious reason why Ceres would have much geological activity or an internal geothermal heat source that would be sufficient to melt ice to water – and it's a bit far out for the Sun's heat to do that on its own.

To date our best observations of Ceres come from the Hubble Telescope which only gives a hint of faint surface features, so it's hard to know what really going on there. To get a close up look at Ceres we await the arrival of the Dawn spacecraft, launched in 2007 and due to arrive at Ceres in 2015 – after first flying by Vesta – which is either the second or third biggest asteroid, depending on whether you measure by mass or diameter.

Now, Dawn is an ion drive spacecraft – meaning its main propulsion is achieved by accelerating ionised particles of Xenon gas past an electromagnet – which then blasts those particles out the back of spacecraft. And guess just how much thrust you get from firing subatomic particles at high speed out the back of your spacecraft.

In deference to *Top Gear*, let's do this in miles per hour. Dawn can do 0 to 60 in 4 days. Yeah. Needless to say the ion drive wasn't used to launch Dawn from Earth. Back in 2007, a Delta II rocket was used to give it an initial push past Earth's escape velocity of 11.2 kilometres a second.

Nonetheless, an ion drive is a very efficient spacecraft propulsion system – at least to as far out as the asteroid belt – where there is still enough sunlight to power the solar panels, which power the electromagnet, that accelerates the ions. Well, there's just enough sunlight. It's calculated that Dawn's solar arrays – which can produce 10 kilowatts of power around Earth – will produce 1.4 kilowatts around Ceres.

After leaving Earth in 2007, Dawn used 72 kg of Xenon to increase its velocity by another 1.8 kilometres a second, enabling to enable it to do a fly by of Mars for a gravity assist – taking advantage of some of Mars' 24 kilometres a second orbital velocity back in February

2009 – and it might have even taken a travel snaps of Mars, except the computer went into safe mode for no apparent reason due to a software glitch.

Right now, Dawn is slowly chewing through another 200 kilograms of Xenon to get to Vesta in 2011 – and then it will use a further 100 kilograms to get to Ceres in 2015, leaving it with about 40 kilograms of Xenon for contingency manoeuvring.

All going well, Dawn will commence reducing it's altitude to within 25 kilometres of the surface of Ceres in 2015 – which will be our very first close up look at a dwarf planet because New Horizons won't get to Pluto until six months later. Mind you, it remains to be seen whether either of these celestial bodies will still be classified as dwarf planets – I mean this is a whole five years away.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website with a whole series of podcasts. No ads, no profit, just good science. Bye.