Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Pluto day.*

And finally it was the 14th July 2015 – Pluto day. If I haven't mentioned it before I do this volunteering thing at the visitors centre of the Canberra Deep Space Communications Complex. For a few years now the visitor's centre at Canberra has had a little sign saying that New Horizon's closest approach will be at 9.50 pm on the 14th of July 2015 and we've all been regaling the visitors with stories of how Pluto was a planet when New Horizons launched in 2006, but was then reclassified to a dwarf planet just a few months later. My, how we laughed.

The Canberra complex is part of NASA's Deep Space Network or DSN. The DSN has three sites set at roughly equidistant points around Earth – Canberra, Madrid and Goldstone in California – so we can keep track our ever-growing number of Solar System exploring spacecraft.Because of the Earth's rotation, if you only had one site you could only manage about 8 hours tracking every day – and it would a bummer if one of your spacecraft was flying-by Pluto outside that eight hour window. That's why we have a network of three sites around the planet.

And we do tend to get lucky in Canberra. Way back in 1969 – we got the first video of Neil Armstrong climbing down the ladder, then we got the Curiosity landing on Mars in 2012 (see CA episode 150) and then in 2015 we got some of the first pictures of New Horizons' closest approach.

But before we go any further, we should get this dwarf planet issue out of the way. I totally get how Pluto had to stop being called a planet. In 2003 we discovered the object UB313 and its moon, which were briefly called Xena and Gabrielle until the IAU killjoys stepped in to rename them Eris and Dysnomia. Regardless of its name, Eris was a problem, since on first look it seemed actually bigger than Pluto. We'd known since the 1990's that Pluto was actually one member of a collection of objects in what was known as the Kuiper belt. Nonetheless, we had continued clinging to the idea that at least it was the biggest object in that belt until Eris appeared. With Eris, we either we had declare we had ten planets – with potentially more to come, or it was time to take stock.

And so, in 2006, we decided that Pluto was just part of a belt and hence not a planet. But what about this dwarf planet business? What the heck do Ceres, the biggest object in the asteroid belt and Pluto the biggest object in the Kuiper belt have to do with each other, apart from being big objects in belts? And don't start on about hydrostatic equilibrium. If you think hydrostatic equilibrium is some kind of definitive boundary, go check out a picture of Haumea, which is officially one of the five dwarf planets. Haumea is why the whole business stalled at just five dwarf planets years ago – it's because people looked at Haumea and said *uhh… that's not even round*. The whole dwarf planet concept is just a dumb idea. Pluto, Eris, Haumea, Make Make and Ceres – they're BBOs, big belt objects. Either you're a planet or you're not a planet, there are no *sort-of, kind-of* planets - get over it.

Anyhow, did you notice how I said Pluto is the biggest object in the Kuiper Belt and not Eris? The *Is Pluto bigger than Eris* thing has been a huge question mark since 2003, with most people tending putting their money on Eris. But a couple of days out from the July fly-by, the news came in that Pluto was actually bigger than we'd thought –well past the error margins that Eris' diameter has. So Pluto is bigger than Eris and hence the biggest Big Belt Object of them all. Yay Pluto.

On top of that, since we already knew Pluto's mass fairly accurately, the finding that it was bigger than we'd thought also meant that Pluto was a bit less dense than we'd thought, which meant it had more ice than it did rock, we now think about one third ice to two-thirds rock. Most of that ice was water ice, but probably a bit of carbon dioxide ice and even a smattering of nitrogen and methane ice.

Anyhow, when Pluto day, 14 July 2015, finally came, New Horizons successfully did it closest approach, coming within 12,500 kilometres of Pluto's surface and it was far too busy collecting data to waste time sending that data back to Earth. So, on Pluto day, while I was at Canberra Deep Space Communications Complex showing the visitors around and passing on New Horizons and Pluto factoids, the boffins in the control room were actually getting ready to transmit data out to Pluto. Huh?

It was all about REX, the Radio Science Experiment. Just after the Pluto fly-by, it was planned that New Horizons would turn to look back at Earth – just as first Pluto and a bit later its moon Charon briefly blocked New Horizons' line of sight with Earth. So if we fired a radio signal from Earth to reach New Horizons, just while Pluto and then Charon got in the way of the radio signal, New Horizons would be able to detect the effect that Pluto and Charon's atmosphere's had on that radio signal.

The precision math involved in making REX work involved a bit of Newton and a bit of Einstein, since New Horizons was moving at about 55,000 kilometres when it received our signal from a source nearly five light hours away. That, my friends, is what you call *good science*.

And what else did we learn about Pluto? Well, that question is still being answered. Not only did we not get all the data on Pluto day, given the data bandwidth od deep space radio communication, we probably won't get all the data until around October 2016. Most of it is still sitting in solid-state memory aboard the spacecraft. On the days before and after Pluto day we just got a few good shots so the media would have something to run with.

Anyway, from what we've seen so far, its surface seem freshly laid down, there just aren't enough impact craters. This suggests some kind of periodic resurfacing process. And Pluto has mountains, some around three and half kilometres high, which also look newly formed – well, newly-formed in a geologic sense, meaning they are probably no more than 100 million years old. Their basal structure is probably water ice with a nitrogen / methane coating. So maybe Pluto has some kind of weird ice tectonics? I mean, how else does a three kilometre high mountain range form?

All of these findings suggest some surprisingly dynamic activity for a world with a mean surface temperature of -220C. Such dynamic activity means there's must be some kind of heat source involved. Initial thinking has focused on Charon's formation, which may have resulted from a major collision like the one that formed our Moon.

That collision could have left both objects internally molten for a while and their subsequent gravitational interaction could have sustained that heat for a longer period. So any tidal heating from Pluto and Charon interacting may be barely enough to turn cold hard ice into slightly warmer spongy ice – creating enough dynamic change that the spongy ice might get bunched up together. And over the course of a few millions of years, under very low gravity, these changes might be enough to create distinct surface irregularities that give the appearance of mountains.

The fact that Pluto and Charon are round is a consequence of hydrostatic equilibrium – a feature we know is common to big belt objects as well as planets. The fact that Pluto and Charon seem to have lots of surface irregularities may just be a consequence of them having *barely enough* hydrostatic equilibrium to achieve a degree of roundness, but not much smoothness. Working out the causes of those surface irregularities will no doubt be terribly interesting, but the irregularities themselves are probably not extraordinary. Indeed, if we ever get to see Haumea up close, it’s surface is probably a right mess.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where it’s OK not to be a planet. No ads, no profit, just good science. Bye.