Question 1:

Dear Cheap Astronomy – Is Ceres just boring as $#%@ or is the interesting stuff yet to come?

This question was prompted by the fact the NASA spacecraft Dawn arrived at Ceres in March 2015 and a few people went ooh, look, it's a larger asteroid than that last one we went into orbit around. And then the NASA spacecraft New Horizons flew past Pluto in July 2015 and everyone went HOLY $%#@, WE JUST FLEW A SPACECRAFT PAST A STRANGE NEW ALIEN WORLD WE'VE NEVER SEEN UP CLOSE BEFORE!

The difference in reaction may be a result of the following issues.

The size. The diameter of Pluto is 70 per cent of the Earth's moon. The diameter of Ceres is 40 per cent of the diameter of Pluto. So, Ceres is not just a dwarf planet, it's a very small dwarf planet.

The distance. The straight-line distance from Earth to the orbit of Ceres is over 400 million kilometres, the straight-line distance to Pluto's orbit is over 4 billion kilometres from Earth.

The look. Ceres: Grey and rocky with lots of craters. Novice reaction: Oh, is that the Moon? Pluto: Improbably irregular surface with a big white heart shape in the middle. Novice reaction: What the f&%$ is that?

Incidentally, Mercury probably ranks as the Solar System's most boring planet. Sure, it's got a high iron content and its perihelion progression was an early proof of general relativity– but, at the end of the day, it's grey and rocky with lots of craters.

Anyway…

Alan Stern. New Horizons' principal investigator is Alan Stern. If Elon Musk from Space X wasn't already Tony Stark, then Alan Stern would be Tony Stark. Dawn's principal investigator is… ooh… umm… hmm... Actually, it's Christopher Russell, but you get the idea.

The immediacy. New Horizons flew past Pluto on 14 July 2015 and that was that. The data is still coming in, but it was one single, never-to-be-repeated event. It was an event we weren't sure would work out until it did and there's video of all the mission team jumping up and down with joy when it did work out. For Dawn, it was… hey, look there's Ceres, but don't get too excited yet, because we're going to go into orbit next. Then it was, hey look we're in orbit now, but don't get too excited yet, because we're going to get even closer via a series of narrowing orbits. At the end of the day, no-one really knew when we were supposed to get excited, so we didn't.

Whether more interesting stuff from Ceres is yet to come remains to be seen. For the moment, the main thing distinguishing it from being just another grey, rocky object with lots of craters is the mysterious bright spots.

The albedo – that is, the reflectivity of those bright spots is about 40 per cent – which is what you might expect from ice. However, on a grey, rocky object with no atmosphere, neither water ice nor carbon dioxide ice is going to last long before sublimating into gas. It may be

that Ceres' surface was recently impacted by an object that exposed a patch of sub-surface ice. Or maybe Ceres was impacted long ago by an object that initiated a brief geyser of sub-surface melt-water, leaving behind a shiny residue of salt crystals.

We may get a better understanding of the nature of the bright spots as the mission continues. The lowest orbit that Dawn will manage about Ceres will be in December 2015 – so please, if you can, try to get a little excited then.

Question 2:

Dear Cheap Astronomy – Do please tell us about Planet 9 from outer space.

This question relates to a recent announcement of a hypothetical object in the Kuiper belt, with a orbital period of about 15,000 years, meaning that it is way, way out there – although on a highly elliptic orbit, which sometimes brings it closer in. So, sometimes it is in the Kuiper belt and sometimes it's further out. Its current position can only be nailed down to somewhere with a huge field of view – which is where optical and slightly infrared-ranged telescopes, such as the Subaru telescope on Mauna Kea, are currently searching.

The Kuiper belt is a relatively-stable collection of objects moving in a wide and roughly circular band around the Sun, though at that distance, the Sun's gravity is getting a little tenuous, so Kuiper belt objects tend to have orbits that are more random in inclination and eccentricity compared to what we see in the more-tightly arranged asteroid belt.

It's also fair to say we have less of a comprehensive census of Kuiper belt objects than we do of asteroid belt objects – although in neither case do we have a comprehensive census. Anyhow, for the collection of Kuiper belt objects that we currently know about, most of them move in what seem to be Kuiper-normal orbits, while others – Sedna for example – have quite unusual orbits. Indeed, the existence of the hypothetical Planet 9 is based upon the apparently aberrant motion of six highly-elliptical Kuiper belt objects, of which Sedna is one.

Now, if you are looking for a reason to stay on the fence over this announcement, then here it is. The proposed existence of Planet 9 is based on the premise that we currently have a sound understanding of what's normal in the Kuiper Belt. It is possible we have that understanding, after all we have tracks of over 1,000 trans-Neptunian objects – that is, objects outside Neptune's orbit, and most of those objects are designated Kuiper belt objects. So, six aberrant objects amongst a population of over 1,000 other objects is enough to start thinking there is something genuinely-aberrant about the behaviour of those six objects.

However, the Kuiper belt is close to the limit of our observation range of non-radiating objects – that is, things that aren't stars. So, the number of Kuiper belt objects we currently know about may represent a biased sample of objects that have a lot of mass, a high albedo or are just in close proximity to us. If future technologies find 60 or even 600 hundred objects with similarly-aberrant orbits to the six we know of now, we may be forced to conclude that the Kuiper belt is just a very chaotic place – from which it's difficult to draw firm conclusions.

So, in a nutshell, the hypothesised existence of Planet 9 does look statistically-compelling based on the current sample of known Kuiper belt objects. If its existence continues to look

just as compelling as the number of known Kuiper belt objects grows, then the discoverers might really be on to something. And, in the meantime, if we manage to observe the actual object then it's a done deal… but that might all be a way off yet.

Now, the identification of a planet lying within a belt of other objects, might seem like cheating since one of the 3 rules of planet-hood is that you have to clear your orbit. But the discovery team, including self-proclaimed Pluto-killer Mike Brown have that issue covered.

Apparently, from the way the orbits of the six objects have been perturbed, the mass of the perturbing planet 9 must be about ten Earths – or, to put it another way, about 0.6 of a Neptune. An object with that sort of mass is able to clear its feeding zone within 4.6 million years, which is apparently acceptable under the fine-print of the orbit-clearing rule.

So, as for whether Planet 9 really exists… for now it's probably best to watch this space.