Question 1:

Dear Cheap Astronomy – What's the Gaia mission all about?

Gaia is mainly about astrometry – though it may also pick up a few exoplanets, test relativity and find some as-yet undetected comets and asteroids within our solar system. Astrometry is about finding the exact position of stars in relation both to the Earth and to other stars about them. It measuring different stars' distances from Earth by parallax, or for *very*-distant objects, by red-shift – and it also involves taking identical star field observations at different times to identify the *proper* motion of stars – that is how much they actually change their position in the sky, relative to the other stars about them, over time.

Gaia's astrometry mechanism is really just two telescopes, both with 0.5 metre mirrors that are pointing in completely different directions. Because the spacecraft maintains a constant spin rate the same objects will across one telescope's field of view and then the other telescope's field of view in quick succession. Both of the telescopes project an image on to the same charge coupling device array so an image of the same star field tracks across the array twice on each rotation of Gaia and the timing of its rotation and the angle of separation of the two telescopes means that each individual star appears on the CCD within one field of view and again with a different field view over the exact time that it takes for the charge coupling device to refresh to its next data capture. So, on the one hand you will get a binocular view of any object you're looking at and on the other hand your field of view becomes one long rectangular strip.

Beyond that, Gaia also orbits Lagrange point 2 – so it will orbit the Sun once a year, but it doesn't have to orbit the Earth to do so. And so, each year, it is rescanning pretty-much the same strip of sky that it did in the previous year and over the course of an orbit all those circular strips will add up to a full 360 view of the sky that surrounds the Earth's orbit – kind of like how, if you keep winding a long piece of string around and around, it will become a ball. And, it scans the strip of sky that's *perpendicular* to the plane of its orbit – so at *any* point in Gaia's annual orbit, will be scanning about the same strip of the sky to what it scanned exactly 6 months ago, when it was on the other side of its orbit, which will hence give you a maximal parallax view of any object that's in the sky. Nifty huh?

Gaia's mission goal is to maintain these observations for at least five years, that is five solar orbits, over which time it will have captured data from at least one billion stars and indeed, it will have captured data from the same stars seventy times over. Gaia's approach to astrometry will capture data from both the tiny angular difference involved in getting the two telescopes operating in synchrony and from the huge angular differences achieved by observing those stars from one side of the solar orbit and then from the other side. Such observations will enable calculations of stellar distance by parallax and might also identify wobbles produced by exoplanets and the big angular observations. And gathering data from identical fields of view over the course of several years will enable accurate measurement of the proper motion of stars, and perhaps some comets and asteroids in our own solar system that we hadn't spotted before.

To enable even more time-staggered observations, Gaia's data will also be compared with star positions recorded by an earlier ESA mission, Hipparcos which was in space from 1989 to 1993, also doing high precision astrometry. While its astrometry measures weren't as accurate as Gaia's, its data should give more insight into the back history of any objects of interest. Gaia also has a spectrometer to gather red shift data from very distant objects whose distance can't be determined by parallax.

So, that's Gaia – not too shabby for a mission that cost just $750 million. And where we said Gaia's mission goal is to maintain observations for five years? It launched in 2013, so that five years runs out in December 2018. There's pretty-much zero probability that anyone is going to shut this fabulous mission down while it's still operational and it looks like it's going to be extended to at least a nine year mission now – or, at least until something breaks anyway.

Question 2:

Dear Cheap Astronomy – What do you make of Scholz's star

Here at CA we sometimes just get sent a link with the expectation that we'll offer some comment on the general subject area – and that's just fine with us. So, firstly Scholz's star is a binary system composed of a red dwarf and a brown dwarf, the combined mass of which is only about 15% of one solar mass. It's called a 'late find' because it's only about 20 light years away, but we only stumbled across it in 2013. The reason for that is that it's dim and that it has minimal proper motion in the sky, so it doesn't leave much of a track on a long exposure – and this is actually where it gets interesting.

Pretty much everything in the Universe is in motion. But, distant objects don't have much proper motion – that is, a detectable motion against the background star field. In reality, they are moving just like everything else is moving, but they're so far away that their movement only takes up a tiny part of our sky. However, a close object that has the same degree of intrinsic motion tends to have a very obvious proper motion since it's movement can cross a much larger chunk of our sky. So, what's surprising is that Scholz's star is only 20 light years away but it has almost no proper motion. This means it either has to be heading straight for us, or it's heading straight away from us.

In fact, Scholz's star is heading straight away from us – and some clever trajectory estimates and some math has determined that it passed very close by us about 70,000 years ago. Indeed, it was close enough to have passed through the outer region of the Solar System's Oort cloud, coming to within about 0.8 of a light year from the Sun.

So, 70,000 years ago Scholz's star was in the Earth's northern hemisphere sky and lots of media coverage has a picture of a Neanderthal-like chap gazing up at a bright red dot in the sky. But, really it's unlikely that it was visible at all. Red dwarfs just aren't that bright and even at 0.8 of a light year's distance, Scholz's star probably only had an apparent magnitude off 11 – and you can't see anything past 10 with the naked eye. There's speculation that Scholz's star might have made itself brighter by throwing off a stellar flare or two during its close pass, as red dwarves are want to do, but even then you'd have to be looking right at it to see that intermittent brightening and it still wouldn't have been all that bright – so no, the Neanderthals were probably blissfully unaware that anything was going on 70,000 years ago.

Scholz' star is thought to have perturbed some comets as it passed through the Oort cloud, although even if some of those had been sent on a death spiral towards Earth 70,000 years ago, it will still take another 2 million years before they actually reach Earth.

The Scholz's star discovery has prompted a review of likely future close encounters with stars. Just on the basis of the density of stars in our galactic neighbourhood, it's likely that a Scholz-like close fly-by occurs every nine million years or so. And it turns out that Gleise 71 will make a close pass in about 1.2 million years from now, coming within just 0.2 of a light year from the Sun. So, as well as coming a lot closer than Scholz's star did, it's a bigger K class star. It's still only 0.6 of one solar mass, but it's bigger and brighter. So, it will definitely be visible from Earth when it passes, probably as bright as Jupiter or Saturn. It won't come close enough to gravitationally perturb either the Kuiper belt or anything closer in, but it is likely to perturb Oort cloud comets and could potentially send some our way.

Of course this will all happen 1.2 million years from now and those perturbed comets might then take another several hundred thousand years to reach the inner Solar System – and who knows how many comets we're actually talking about since we have no data on comet density in the Oort cloud, although it's quite likely to be not very much. And heck, all this is going to happen a million or more years from now, when we'll either all be dead or we'll be roaming the galaxy as immortals in robot bodies, having left our home world protected by some pretty serious technology that would easily deflect asteroids or comets or even invading alien hordes, for that matter. So, there's really no need to lose sleep over this one. If you're looking for a doomsday scenario, keep on looking – and perhaps you should be looking much closer to home.