Question 1:

Dear Cheap Astronomy – Selfies in space.

Buzz Aldrin claims to have taken the first selfie in space in 1966, where he fixed a Hasselblad camera on the hull on Gemini 12 and then leant back before triggering the camera. Later on in 1969, Neil Armstrong took an accidental selfie – the only still photo of him on the Moon where he and his camera are reflected in Buzz Aldrin's visor.

Indeed helmet visor reflection pics are a bit of thing. You can take a selfie of you against an interesting background and also capture the foreground reflected in your helmet visor. Some of the older ones, including the Neil Armstrong selfie have been 'unwrapped', meaning the image captured on the concave surface has been flattened out with imaging software – so you can see the image in its original form. It's one of those meh things, technically challenging and historically-significant to be sure, but the image was low res to start with – so even after the unwrapping it still looks pretty meh. Anyhow, just google Buzz Aldrin visor unwrapped if you're interested.

There have been some moments in Earth-Moon exploration where a camera on one craft has taken a full picture of another craft – so for example, some Gemini docking tests, numerous Apollo images of one module taking the photo of another module and also lots of space station photos taken by craft either docking or undocking from them – and also those craft were snapped from the station. For example, after the Columbia disaster, shuttle orbiters would routinely do a 360 degree rotation near the ISS to allow their thermal protection tiles to be examined for flaws.

But we digress, this week's question is actually about space robot selfies. So firstly, brace yourself for a shock folks, all those fabulous NASA promotion shots of Cassini in orbit around Saturn or New Horizons flying by Pluto are composites of a drawn image of the spacecraft against a generally real image of the planet it's visiting – but sometimes that's just a drawn image too. For example in the case of the Parker probe, it's a promotional pictures are always shown against an artistically-enhanced red Sun, since a blindingly white image of the real Sun just wouldn't work.

Of course, the best robot selfies of all are the Mars rovers. Spirit and Opportunity took photos of themselves from above from a mast mounted camera. These showed both rovers solar panels getting increasingly dusty, but also later being cleaned after a gust of wispy Martian wind. Curiosity and Perseverance can do more interesting selfies with their cameras on a mobile arm. So their selfies are either front or side on so you get nice Mars views in the background as well as seeing the complete rover. The apparently invisible camera arm is managed through joining up multiple shots where any parts of the rover obscured by the arm in one shot are overlaid by another shot from a slightly different angle. There's also a photo of the very first rover Sojourner on Mars in 1997, though that was taken by a camera on the Pathfinder lander.

Alas, it's not likely we see selfies from interplanetary spacecraft anytime soon. There's not much to be gained from visualizing a spacecraft that flies through a vacuum – you might see the odd micrometeorite dint and other surface degradation from cosmic rays and sunlight, but there's not much you can do about it even if you can see it. Putting a camera on a swivel mount just adds a potential point of failure to billion dollar decade-long missions. It wouldn't have been much fun to have New Horizon's camera stuck in selfie mode as it did its one fly-by of Pluto.

The recent uncrewed and hence robotic Artemis 1 mission did manage to take some nice shots from its externally mounted camera, which captured parts of the craft with the Earth and Moon in the background.

Question 2:

Dear Cheap Astronomy – Is Hawking Radiation real?

Long-term listeners are probably familiar with Cheap Astronomy's tendency to go a bit ranty in the face of any unreasonable acceptance of cosmology hypotheses. So, for example, the Universe is not only expanding but that expansion is accelerating. Sounds extraordinary, but there's sound observational evidence to back it up. Cosmologists are keen to explain why this happens and the current working hypothesis is there is that it's driven by a mysterious form of energy that doesn't obey the laws of thermodynamics and so far is completely undetectable. Despite that, if you follow the logic through it turns out that this utterly inexplicable and undetectable stuff represents about 70 per cent of the current Universe's energy-mass contents. So, this sounds extraordinary and there is no observational evidence at all to back it up. That's doesn't mean it's wrong, but it doesn't mean it's right either. It's just the prevailing hypothesis we are running with at the moment.

So, is Hawking radiation real? Well, it might be – but at the moment, it's best considered a clever and interesting idea that no-one has found any definitive evidence for or against. And that's no criticism of the late Professor Hawking. This is science at work, people kick some ideas around, some get shot down quickly and some don't and sometimes someone thinks up a physical experiment to either prove or disprove one of these prevailing ideas. So for example, the notion that time might run differently in different parts of the Universe seems pretty extraordinary, but all you have to do is fly clocks around at different altitudes to demonstrate that it's really true.

There are a range of experiments that allegedly demonstrate the existence of Hawking radiation, though based on use of black hole and event horizon analogies – which are not enormously compelling analogies really, given that proper black holes involve some fairly extreme physics which can't be readily replicated on Earth. Such analogous experimental set ups may allow you to conclude that what you observed was consistent with the existence of Hawking Radiation, but you couldn't really say Hawking Radiation was the only possible explanation for what you observed.

The genuine detection of Hawking radiation around black holes is unlikely to be achievable since any black hole undergoing accretion would already be radiating an overwhelming amount of conventional radiation. Also, you would be unable to detect any degree of black hole mass loss due to Hawking Radiation losses since a black hole in this age of the Universe absorbs more cosmic microwave background radiation, not to mention other radiation, than it would lose from Hawking Radiation. So, it’s unlikely that anyone is going to observationally detect in situ Hawking Radiation any time soon.

To recap, Hawking proposed that virtual particles which allegedly pop into existence and self-annihilate a moment later might dissociate near a black hole’s event horizon with one remaining outside and the other being sucked in and then annihilating with something within. So, the Universe gains a photon and the black hole loses one photon equivalent of its mass-energy contents and the net result of all is that over a googol years or more the black hole evaporates.

This leads to the black hole information paradox. Supposedly information is never really destroyed, just transformed. So you can throw an encyclopedia into a furnace and the information is still kind of sort of there in the heat and the ash. But with Hawking radiation the radiation sent back out into the Universe has no causal connection with what’s inside the black hole, they’re just photons that originated from our side of the event horizon. Of course, one solution to this paradox is that Hawking Radiation is just an interesting idea and doesn’t actually lead to black holes evaporating at all. Who knows? For now, we’re just going with this as our current working hypothesis while we wait for more data. So, is Hawking Radiation real? Maybe.