Question 1:

Dear Cheap Astronomy – How far away are we from building the first Moon base?

Regular Cheap Astronomy listeners will be aware we have a tendency put a dampener on things. For example, sure we could be flying astronauts to Mars in the 2030s. They might arrive there with cancer, osteoporosis, uncorrected myopia and a strong desire to kill each other after being locked up in the same room for 7 months – and there'd only be an 80-90% likelihood of them actually arriving at all, but sure we could do it. A few world governments just have to work together and pitch in several billion dollars a year each for a decade or more. No problem.

But, don't get us wrong. It's good to inspire people with a sense of wonder and purpose, really. But it's also good to engage with the detail sometimes. If we keep avoiding talking about the problems, no-one is ever going to come up with the solutions.

So, just to get a bit real for a moment, humans haven't left orbit since 1972. The idea that we'll suddenly get energised again and decide that the first trip out should be to another planet is not a likely scenario. NASA's intention to make the first trip out be a trip back to the Moon , or to a near-Earth asteroid is a much more realistic plan.

After that, a lot of people think the step should be to establish a Moon base and here at Cheap Astronomy we agree it should be the next step. But all the current speculation about how we'll land giant 3D printer robots that will convert Moon dust into paving stones and building blocks is just that – speculation. If using naturally-occurring silicon-based particles to 3d print building materials was both technically-feasible and cost effective – wouldn't we be doing it now with beach sand or something? And even if it wasn't all that cost-effective, wouldn't NASA be at least trialling it with beach sand or something?

So, sometimes it's good to take a step back from all the speculative futurism. If you want to live in a pressurised compartments on the Moon – and, let's face it, that is the only way you are going to live there, you are going to have to fly up materials from Earth. We'll probably need steel frameworks and glass windows , or maybe inflatable modules if that technology really survives the test of time.

Nonetheless, there's a need to launch a whole lot of mass from the Earth. Once you've built something on the Moon, it would make sense to then cover that building work with some kind of Moon dust cladding to provide protection from radiation and micrometeorites, but there's no way you can build a habitable structure solely from just lunar resources in the foreseeable future.

And there's the non-trivial issues of needing water and a breathable atmosphere. Sure, we 've discovered that lunar regolith has some water content, indeed quite a lot more water content than anyone had assumed – and of course once you've got water you've also got hydrogen fuel and oxygen. But it's not clear that anyone's done the math on the extraction costs involved in getting that water out of the regolith, costs which may include trucking tonnes of water over long distances from high yield areas like shadowed craters near the Moon's poles. So, when we do the math, it might turn out that it's still cheaper and quicker to just launch big tanks of water from Earth – even though that would be neither cheap, nor especially quick.

So, yes it’s great there are lots of great ideas out there – and let’s keep them coming. But it’s not clear there’s yet been a game-changing idea that’s going to make everyone go – well, if we can do that then of course we should build a Moon base.

Of course, if we were mad keen to not only fly to Mars, but to fly to Mars on a regular basis, then we’d have the economic rationale to build a Moon base way-station – or even a launch site. Alternatively, we could do science on the Moon– but we’re already doing science on the ISS. And if you’ve ever listened to that great podcast – I think it’s called science on the ISS? – then you’d know that about 75% of ISS science is microgravity science. And you can’t do microgravity science on the Moon – you can do 1/6th gravity science, but there’s not actually a big demand for that right now.

So, to summarise, if you want to build a Moon base –we have the technology. What we don’t have is a business case that incorporates a quantifiable return on investment. So, as soon as we can build that business case – we can build that Moon base.

Question 2:

Dear Cheap Astronomy – What’s your response to the Fermi Paradox.

The Fermi Paradox is usually just paraphrased as “where are all the aliens”. But the actual paradox involves it seeming inconceivable that we could be the only technologically-based civilisation around, that is able to transmit messages and send spacecraft from our planet. But, at the same time, here we are looking out and listening out for signs of anyone else having figured out the secret of banging the rocks together and – zip.

But before we get too pessimistic let’s consider that to whatever extent we are an example of an advanced civilisation, we aren’t actually all that noisy. Although we have been broadcasting radio and TV signals for around 100 years – and hence those signals have spread out one hundred light years in all directions, their signal strength has attenuated over distance by the inverse square law.

It’s unlikely our current technology would be able detect our own radio transmissions from just four light years away, say from Proxima Centauri, which is the closest star to our Sun. We might manage to detect our very loudest broadcasts to date, which have been in radar rather than radio, but already modern broad frequency radar is much quieter than the blaring narrow frequency radar we used in the twentieth century. Similarly our civilisation is becoming increasingly radio-quiet as we steadily shift away from radio and TV broadcasting towards cable and fibre-based comms. So, after a few brief decades of noise, our advancing technology looks to be making us quieter, not louder.

So, a simple response to the Fermi paradox, is to assume that we are a good example of an advanced civilisation and that currently we would be unable to detect ourselves from any reasonable interstellar distance. And while there could be more technologically advanced civilisations out there, being more technologically advanced doesn’t necessarily make you easier to detect.

Mind you, our own technological advancement is going to make us much better listeners. It's likely that when it's fully established, in fifty years or so, the Square Kilometre Array will give us the capacity to detect signals equivalent to our post WWII narrowband radar from several hundred light years away. That's still only a small proportion of the whole Milky Way, but it will be a big step forward in SETI – perhaps enough to put the whole Fermi paradox to bed once and for all.

We can only guess at how many Earth-like planets are out there. To date, we've been able to identify Earth-sized planets around red dwarfs, but these are not likely candidates for harbouring a complex ecosystem, let alone a technological civilisation. We don't yet have the ability to identify the much more likely candidates, which are Earth-sized planets around G-type stars, like the Sun.

Out of the several hundred billion stars in our galaxy, there are 7 or 8 billion G-type stars and we could say there's up to 27 billion somewhat Sun-like stars if we include the adjacent F and K types as well. On this basis, it's speculated that the Milky Way might contain some 50 million Earth analogues and another 25 million Pandora analogues, where Pandoras are exomoons orbiting gas giants that are orbiting within their star's habitable zone.

But given everything we've covered in this podcast, perhaps the only way an interstellar conversation is ever going to start is if someone deliberately tries to get themselves noticed. Here at Cheap Astronomy, we feel confident that Earth could start broadcasting yoo-hoo, over here messages, without the slightest risk of any war-mongering aliens warping over here, at faster than the speed of light – because, you know, physics.

But, for anyone to actually hear us, from more than 5 or 10 light years out, they would eed some very sensitive equipment – and they'd probably have to be in line of a beamed transmission we'd sent to have any hope of distinguishing our signals from the normal background noise of the Universe. So, for the moment since it doesn't look like we'll be sending such a beamed transmission any time soon, it's likely any aliens out there will be struggling with their own versions of Fermi's paradox.