Question 1:

Dear Cheap Astronomy - Why are there more luna maria on the near side than the dark side?

Firstly for the benefit of the other listeners, maria is the plural of mare – as in *Mare Tranquilitatis*, the Sea of Tranquility and other maria, including *Serentatis, Vaporum*, and *Insularim*. There is also the biggest mare of all, *Oceanus Procellarum* – which is not to be confused with *Procul Harum*, a progressive rock band.

A lunar mare is thought to be result of a large object hitting the Moon at high speed during the Moon's early life, when it still had a molten interior. So when an object impacted, it penetrated the Moon's crust and caused magma to gush out, forming a large round pool on the surface, which then cooled and solidified into a flat plain of rock. The grey coloring of maria, darker than the rest of the Moon's crust, is because the rock is metal-rich basalt while the Moon's crust is mostly low-metal feldspar.

The near-side is the only side that we get to see of our gravitationally-locked Moon from the Earth. The far side, or dark side, of the Moon is something only 24 people have seen with their naked eyes, three of them on two separate trips (Jim Lovell, John Young and Gene Cernan). The rest of us have only ever seen the far side via remote photography or remote video.

It turns out that maria cover 31% of the near side, but only 1% of the far side. The far side also a lot more craters per square kilometre than the near side does, although arguably that's just because it has fewer maria. A mare wipes the slate clean – after the impact, magma wells out and fills in whatever craters may have been there previously. So we are back to the question of why there are so many mare on the near side.

The quick answer is that no-one really knows, so on the off chance that you've been inspired by this podcast to start a PhD – there's a topic for you. There are two main hypotheses out there. Perhaps the near side had an assymetric concentration of underlying molten rock, meaning that the near side was much more prone to mare formation than the far side was. The assymetric distribution of molten rock may have been due to an assymetric distribution of radioactive heat-producing elements such as thorium and uranium.

But if you don't like that theory much – and a lot of people don't – there is another theory. As you probably know, we think a Mars-size object collided with proto-Earth Mark 1 about 4 and a half billion years ago – resulting in the current Mark 2 Earth, surrounded by orbiting debris that coalesced to form the Moon. But, after the Moon had fully formed, perhaps the far side of the Moon was struck by more orbiting debris – perhaps even in the form of a small second moon.

This low-velocity impact may have been a face-covering splat, rather than a point-focused impact. The face-covering splat either thickened the far side crust to the extent that it made it immune to mare formation or perhaps that splat came later to erase any previous mare on the far side, so that we only see them on the near side now. Actually the erasing of a previously even distribution of mare is just Cheap Astronomy's suggestion. It seems about as plausible as the other ideas that are being tossed around at the moment.

There is growing a growing body of data on this issue from recent missions like the Lunar Reconnaissance Orbiter, which seems to confirm that the far side crust really is thicker. The gravity-scanning GRAIL mission, which ended in 2012, seems to confirm that the near and far side had received an even distribution of impacts over their life, although the GRAIL mission scientists favor a hotter crust on the nearside as the primary cause of the predominance of near-side maria.

So lots of data coupled with lots of wild conjecture and heated disagreements amongst the experts in the field. This has PhD project written all over it. Good luck.

Question 2:

Dear Cheap Astronomy – Are other planets in the Universe mostly made of the same stuff we see in the solar system, or could they be really alien?

Well, the quick answer is that we don't know. But since this is a five minute podcast, let's get there the long way around. Firstly, we do know what nearly all of the elements in the Universe are. The periodic table has all the variations that are possible from the simple addition of protons and neutrons within a nucleus. The table is completely filled until you get up to very high atomic weights, at which point atomic nuclei are so unstable that they quickly decay into lighter elements or isotopes in a fraction of a second. So, we aren't really expecting to find any new elements, previously unknown to science, when we go out to explore the Universe.

But of course, planets don't generally come in elemental form. The Earth's crust is made up of complex minerals, variously composed of elements like silicon, carbon, aluminium, calcium and magnesium, most of which have been oxidised in some way – remembering that oxygen is by far the most common element within the Earth crust.

The most common mineral in the Earth's crust, feldspar, makes up 60% of the crust and contains potassium, aluminium, silicon, oxygen, sodium and calcium – in various states of oxidation. Feldspar literally means field rock without ore. So, feldspar is essentially generic rock, the stuff found between all the economically-exciting minerals that we like to mine – although these days even feldspar is being mined for a number of arcane industrial purposes.

We already know that feldspar is not unique to the Earth. Unsurprisingly, since we know the Moon is composed of proto-Earth debris, the Moon is primarily feldspar. Evidence from the Curiosity rover suggests that feldspar is present and indeed probably common on Mars. Spectroscopic data from various orbiting spacecraft suggests that feldspar is also a significant component of Venus and Mercury.

But of course, to have a stellar system with rocky planets that contain feldspar, you first have to start with a dust cloud of oxygen, carbon, silicon, aluminium, calcium and magnesium, which subsequently collapses down into a star with orbiting planets.

The Sun is a Population I star – essentially a third generation star built from a dust cloud that was already heavily-seeded with elements formed by the fusion-nucleosynthesis of a previous generations of stars.

If the very first generation of stars, Population III stars, had planets, they were presumably all hydrogen gas giants, perhaps with some helium and also traces of lithium and beryllium – being the leftovers of Big-Bang nucleosynthesis.

Population II stellar systems may have a richer mix of more complex elements, but current thinking is that they only have gas giants too. The sparser concentration of heavy, complex elements in Population II systems may not encourage accretion into planet-sized objects. Also, the lower relative proportions of iron and iron-associating elements means such planets would have relatively small iron cores, making them more susceptible to breaking up after a serious impact.

On the bright side, even if stable, rocky worlds are only found around Population I stars, there’s an awful lot of Population 1 stars out there – particularly if we think about what’s out there now, like today now, rather than the way things appear to be at million or billion light year distances.

It’s uncertain whether all rocky planets around population 1 stars are 60%-feldspar-rocky, or some other type of rocky. The preponderance of feldspar may just be a consequence of the particular chemical composition of the dust cloud that formed our solar system and the particular temperature and solar wind dynamics that a G spectral class star produces.

On the other hand maybe feldspar really is the dominant rock out there. As it stands, we don’t really know – but if we really wanted to, we could find out.