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Stars Over Surrey. A monthly guide to astronomy and developments in space with Graham Laycock and Rachel Dutton of Guildford Astronomical Society.

And welcome to Stars Over Surrey Artemis two Special with Graham Laycock and Rachel Dutton, fellow of the Royal Astronomical Society and Director of Outreach at Guildford Astronomical Society. Well, Rachel, what an exciting time. Yes. It's the first time since 1972 that humans are headed back to the Moon.

Absolutely. And I'm old enough to remember that first Moon landing. Wow! With the very grainy pictures and that, stars and stripes flag being pushed into the surface there. I think it was a fairly stiff flag. I seem to remember as well. Yes. Because there'd been, wouldn't be the wind to keep it fluttering, I don't think.

No. And they also, I think they put things in it to make it sort of prop up. Yes. So maybe wires or something inside. Yeah. One small step for man. Yes. Yes. So has this brought back any sort of memories or emotions for you? It has, it has really, I just think it's such a shame. It's been so long. Yeah. But at least we are at it now again.

But, very exciting indeed. You know and we hear that they've now left Earth's orbit and they're really on the way to the go round the Moon. Yes, and I'm right in saying I think they're going to be the furthest away from Earth than any human so far during this mission. Yeah. Yeah. So the orbit around the Moon is going slightly further out than previously, so they're going to be about,, 3000 km further out than previously.

And it's the first mission with a woman on it and with a person of colour as well, going to the Moon. Yeah, that's true, isn't it? Yes. So we're just, and the first Canadian, yes. Can't forget our Canadian friend. Yes. Mustn't forget that either. No. Anyway, would give us a little bit of a round off of this Artemis program.

The Artemis Programme Overview

Okay. So the Artemis program, when it was initially. Thought up was how we are going to do human space flight further. And the end point was having the space station around the Moon in the near recto-linear halo orbit gateway, which would be a mostly unmanned space station. But with people going there and sort of looking after the experiments, which would be mostly automated.

And then they could go down to the Moon and back up on that space station and take samples and do things like that. And the Artemis one mission, which happened in 2022, that was unmanned. It did have a little Shaun in the sheep and a little Snoopy in there. It also had two human phantoms, so they looked like mannequins and they have this material on that has the same radio opacities skin.

So, they could see how radiation affects. Both of those phantoms, one, they put, the amount of fabric in front of the sensors for the female organs and one for the male organs. They're called Helga and Zohar. I have met Helga on my visit to the European Astronaut Centre because I've done some space medicine research with the European Space Agency, and I haven't met Zohar.

That data was taken so they could analyse the impact of radiation on astronauts when Artemis one returned. There were various issues with the life support system and the heat shield and a few other things as well. So the life support system, you obviously need your astronauts to be able to breathe, to have the right pressure, et cetera, to be able to survive the journey, and then the heat shield.

When you come back into re-entry, you are going to be heated up to about half the temperature of the sun's surface. So, you need the module to be able to dissipate that heat and protect the inside from that heat in order for astronauts to to survive. So those were the biggest delays in Artemis two going ahead because they had to nail both those to make sure that our astronauts could survive the journey.

So Artemis two is astronauts onboard doing a loop around the Moon and they are checking now the sort of technology work so they can communicate all the way around the Moon and that they can fully steer things that the automation works, et cetera. Artemis three due next year. That one was originally supposed to have the first lander, but we've reported before that there are delays by SpaceX on the lander, and now Blue Origin are having a go at creating a lunar lander as well.

But what they're going to do is closer replicate the Apollo pattern of missions. But with the new technology, that's very different and they're going to practice docking and un docking the landers whilst in orbits. They won't land on the Moon, but they're going to practice that they can dock and dock safely.

Artemis four, which is slated for the year after that at the moment, I'm sure both are going to be delayed will be including the actual landing on the Moon by the lander, maybe with or without astronauts. And then Artemis five, the last one they've got any idea about would actually be landing on the Moon.

There are talks of six, seven, and eight, however last month Jared Isaacman, the new administrator of NASA, did say that he is looking at having a full-time lunar base established on the Moon, for a number of reasons. So one, it could be a lunar outpost for future space exploration, maybe to Mars.

Lots of science that we can do on the surface of the Moon like we have done on the space station previously. And so it looks like the Lunar Gateway Space Station probably has been shelved now as a result of that. Lunar base on the Moon is the endpoint. We've also got a bit of competition from China who are hoping to get humans on the Moon by 2030, and they seem to be pretty much on target.

So that is the overall feel and goal of the Artemis mission. Right. And maybe longer term it's a stepping stone on the journey to Mars.

The Launch

Yes, right. Anyway, , an exciting launch we saw, did have an odd one or two pauses, didn't it? For technical issues. It did. So we can talk about those.

First the two technical issues. They didn't actually pause things for because they could carry on going. So there were two sort of big issues that they needed to fix. The first one that came up was the flight termination system. And that one is if the rocket looks like it's going to veer off course, they can remotely take control of it and move it to somewhere where they're not going to.

You know, destroy bits of the Earth or anywhere inhabited by people. The second one was the launch abort system. So this is, you probably saw all the preparations. There was a big tower right next to the rocket and there was walkway, like a jet bridge that you get the planes. Yes. They do all their preparation in the white room, in the tower before going through, they do a load of checks, then they're sealed.

Then the tower is retracted back, at the point it's retracted, the Launch abort system, is a really important part of this. If, for example, there is a runaway fire or something's gonna go wrong and

it looks like the rocket's going to explode, there is essentially a tube. So like the water parks where you've got those completely enclosed.

Yes. Tubes that you can go down in. It's one of those, they evacuate in that it's fireproof. It takes them into an underground bunker. So even if everything explodes or catches fire, hopefully they survive at the bottom. That has to be fully armed once they are in that rocket on their own. And what happened was they had a reading that one of the batteries was at a high temperature and it turned out it wasn't the battery.

It was one of the sensors reading the battery's temperature. And they said they cleared the issue, so I don't know if it was they reset the sensor or they had other sensors that were able to take the place of that one. And that one's obviously critical for crew safety as well. So they carried on going with the countdown, and then most people noticed that they stopped at.

T minus 10 minutes, which is the time that's called the terminal count. That's when the systems switch from external control of the rocket to the automated systems in the rocket takeover control. And that's where they did the pause. The reason for that wasn't anything big. They were essentially doing the equivalent of, you're probably aware that pilots do like pre-flight checks.

Yes. So on commercial flights, and they, they're supposed to do on their private flights as well. Imagine an epic version of that. There's something like 800 checks that they have to do, and they go around every single team involved. So all the engineering teams essentially, and various other cross-functional teams, every single team has their own checks.

And you probably heard them saying things like. "Booster Go. GNC Go. Range Go." Each team was giving their go ahead and this was called the "Go/No go call". If one person said "No go", the whole thing would've been delayed or scrubbed at the very end, you had the call "Artemis II, this is launch director, you are go for launch."

That was the confirmation that they could go, and then Reid Wiseman responded, "we go for all humanity". And then it took like two minutes for them to restart that t minus 10 minutes. And that after that point was pretty flawless, I thought. Yes. Yeah. Very, very spectacular indeed. Yeah. And I see,, subsequently on the internet that a few lucky people on commercial flights took,, videos outta the aircraft window, seeing the the takeoff.

Yeah. What a treat for them. Yeah, absolutely. What struck me with, I suddenly realise that, well, they're, they in that capsule for 10 days. They strapped them in. Are they're going to be stuck, strapped in, or they're gonna be room to move around. But I saw then later pictures Yes. They're, they are able to move around and they were outta their spacesuits.

Yeah. So the pressure suits are specifically for launch and. Landing and when they're doing risky manoeuvres, so when they're in the Earth's atmosphere, they can heat up and there can be fire around it or plasma that heats up, which can be dangerous. You've got a risk of depressurisation during risky manoeuvres, such as launching and landing and things like that.

And also, if you have a fire on board in the space station, the first thing you do is put on your pressure suit. So that is their emergency life support system and those suits can keep them alive for six days. So they're really important. They wear those for the takeoff. Once they are, if you to give the flight analogies at cruise, as it were, and they've tested everything that they know they're safe, they can then switch into the standard astronaut uniform at that point, which is sort of Chinos and a polo shirt.

And they've got a lot more space in that capsule. It's still very snug. Yes. They can't move around that much. But compared to the Apollo missions, if you imagine the Apollo missions, imagine like, I don't know, a Toyota estate. Yeah. Yes. Okay. And now you've got, equipment underneath you instead of a chair.

So you're sat on equipment and then coming out from the walls, you've got equipment, and then you've got equipment coming down from the ceiling. Would've been very claustrophobic and they couldn't move much at all. Whereas these guys actually have exercise built into their day. So part

of the, their mission is setting up their exercise to get their half an hour of exercise in so they can move around a bit.

I think on the press bits I've seen, you can see three of them can sort. I say stand, but kind of float. And what happens when you're in zero gravity is your arms naturally sort of float up in front of you. So you'll notice they cross their hands or put them in their pockets and the legs sort of bend and float up a bit as well.

And you'll notice, that that happens. So they've got space for sort of three of them, and then one of them sort of like in the side, sort of tucked into some equipment, horizontally. Sort of the head height of the others. So they can move around a bit. They can exercise, they've, they've even got a toilet on board what luxury.

Photos of the Earth

Indeed. Indeed. And I know they've been asking advice of NASA about how to clean the windows. Yeah. 'cause they've been taking these amazing photographs. Yeah. But I, but I think the windows have been getting a bit dirty. Yeah, so on the inside they were peering out, so it might have hand prints and smears there.

And on the outside, you might have sort of little particulate debris from the launch with all that smoke going around it. Oh, yes but there have been some spectacular pictures already released. So you can go to the NASA's website. Graham, you said you looked at them? Yeah. So I know there was one image that was the globe.

Earth from Artemis II day 3 on the Night Side, you can see the daylight bottom right.
Credit: Reid Wiseman NASA

Earth Day/Night from Artemis II day 3.
Credit: Reid Wiseman NASA.

Yes. And it, a lot of people said it doesn't quite look as bright as the Apollo 11 image, but the Apollo 11 image was taken on the day side of the Earth and this one was taken on the night side of the Earth. Oh, right. And he look. Bottom right. It's actually lit up. So it's like a very thin way,, waxing Crescent Earth right point.

And it, what they did was they did a long exposure so that they could get enough detail on it, which is an actually technique. Yeah. then you've got the, like the day and night Earth Yes. Picture. That's quite spectacular. Yes. Yeah. And then they've gone back from the window a bit so you can see the Earth out the window from their view, which.

That must be amazing to experience the overview effect and to see Yes. I think all the, yeah. Previous astronauts have say, looking back at Earth is, is quite something. Yeah. Anyway,,

they're on their way. I believe it's on the Monday the sixth that they, they go round the back of the Moon and they start coming back towards Earth.

Day By Day Break Down of the Mission

Yeah. So,I do have a note of all the days of the mission and what they're gonna be doing on each day. So, I won't go into too much detail.

Day 1

Day one launch, that is quite a big day for them. They had to go through a number of medical checks, to check everything for them personally, they've already done two weeks in quarantine where they can only have adult members of their nearest and dearest in contact with them because children obviously pick up lots of things from school. And then whilst they're doing that, you've got all the engineering and technical checks going on as well.

Day 2

Day two, the crew set up Orion's exercise equipment. All the astronauts will complete a 30 minute workout on the flywheel each day of the mission.

The main event of that day was the trans lunar injection burn, so the injection burn to take the rocket away from the Earth. And then, before they did all that, they had to do all their checks. Basically they had to see if they could break their module. So they were doing communications checks. Can they breathe?

Is the atmosphere fine? Do they have the right pressure? Can they steer with six degrees of freedom? So you've got pitch elevation. Can they go up and down? Can they roll from one side to another? And yaw so can they turn left and right? So that's your six degrees of control.

Day 3

On day three, the brief burn of the engine called the outbound trajectory correction, ensures that Orion stays for the target of the Moon.

The astronauts will spend the rest of the day checking systems and kit, including their CPR procedures in case in space. That's a fun one because chest compressions, I'm sure you've seen people do chest compressions in space. You invert, so you're doing a headstand and you do your chest compressions over the top of your patient whilst upside down from our perspective.

And they're checking all the medical kits and things. They also rehearse the observation work that they've planned for flight day six. So they practice all the various different observations and experiments they're going to do. So if it's one of them has to hold this up, another one has to catch it or something like that.

Or they're going to be using specific equipment. I've seen,, medical experimentation, flights even just done on parabolic flights. They rehearse, I'm gonna take blood outta this person's arm in zero gravity. They rehearse doing it, in the actual rocket or plane first, so they can get a mental model of what the whole thing's going to look like. So they can just do it in situ when it comes up.

Day 4

Day four is the second outbound trajectory burn that will keep our eye on its path. The Moon, the astronauts will spend time studying their individual objectives for the Moon flight day six and revising the Moon's geography so they know exactly what they're looking out for.

They'll also have 20 minutes in their schedule for taking pictures out the window. Obviously, they're gonna do that throughout the mission, but this is specifically time for them to take those closeup pictures.

Day 5

Day five, they will enter the Lunar sphere of influence. At which point the pull of the Moon's gravity becomes stronger than the pull of the Earth's gravity.

The morning will be focused on testing their spacesuits, which is their critical survival system, and during the afternoon, the final outbound trajectory correction burn will take past before they fly past the Moon on day six.

Day 6

Day six. Big day, they will pass around the far side of the Moon, but unfortunately that's going to be the night side of the Moon.

Yes. So they won't see that much. This will be further than anyone from Earth has ever traveled, which is amazing. And they will spend most. Of the day taking photos and videos of the Moon and recording their observations. And is this when we lose contact with them on radio wise? Yes. Yeah. For about 40 minutes.

Right, so they're aware that that's going to happen. I'm sure there's always going to be part of them that feels a little bit uncomfortable with that. But just bear in mind, these are super qualified people with. Like pilot backgrounds and things like that. So they are used to dealing with that amount of uncertainty and being uncomfortable in those kind of situations.

Day 7

Day seven, they will exit the Lunar sphere of influence. In the morning, scientists on the ground will have a chance to speak to the crew and ask them questions about what they observed whilst it's fresh in their mind. In the second half of the day, the crew, the Orion engine will fire again for the first of the three return trajectory correction burns, and most of the day will be spent off duty just to give them a time for a bit of a mental break because.

That time around the Moon, it's really jam packed with everything that they have to do, and they've got to be really on their a game. There is no, space to get behind on the schedule for an experiment not to work. So if you, if you imagine just, you know, when you want to show someone something on your computer and this doesn't work and that doesn't work, and all the rest of they don't have time for that, it's gonna be really compressed and they have to be super, super engaged and mentally on it the whole time.

So. Day seven will give them a, a bit of a mental break, which is important because they have to be, again, super focused to come back and land safely.

Day 8

Day eight, the crew will build a radiation shelter in a demonstration to assess their ability to protect themselves from high radiation events like solar flares.

This is really important because, at the ISS, they go and hibernate in, no two when there are big solar storms. they will also try out the Orion's manual. Piloting capability by steering the spacecraft themselves and performing manoeuvres. This is really important for future missions. and they'll be passing that data onto the next crew.

Day 9

So day nine, last full day in space, preparing for their return on Earth. They will do another return trajectory correction to keep the spacecraft., on track, they'll try on their compression garments, which help prevent dizziness caused by returning to Earth's gravity, and they will re brief their landing again.

Day 10

Day 10 final trajectory correction burn will put Orion on the path, will splash down, the crew, will pack their equipment away, get into their spacesuits. The crew module will separate from the service module so that the heat shield is facing forwards, and then they'll go through reentry, with the crazy temperature and splash down in the Atlantic Ocean with, I think it's 11 parachutes attached.

Oh, right, okay then that's always a spectacular moment, isn't it, as well? Mm-hmm. Absolutely.

Other Issues

So, other than the issues before at launch time, nothing else has been of much of a problem. There was so far was the toilet issue that I think most people have heard of. I have to say, every time I do outreach, everyone gets fascinated about astronauts and toilets for some reason.

So apparently it just came up with code, and they didn't know what to do with that and. Christina Cook got in there and became a plumber, as you have to do in space, and spoke with mission control and Capcom and they, they managed to fix it so they have a working toilet. Good, good, good, good. And, of course we've got these four astronauts.

The Astronauts

Let's hear a bit more about them. Okay, so the commander is Reid Wiseman, an American astronaut engineer, Naval Aviator. He served as the chief of the astronaut office, when he was on board on the ISS back in 2014. If you go to his Instagram, he was posting videos of the cruise training over the last few years, every week on Instagram.

So if you really want sort of the inside scoop of what was going on, I highly recommend you go back and scroll through his Instagram, it's a treasure trove, right? Victor Jerome Glover Jr. Is a United States Navy captain, test pilot astronaut from the nasa. Astronaut Group 21. He was a pilot on the first operational flight of the SpaceX Crew Dragon to the ISS.

He was an FA 18 pilot in the US Navy and a graduate of the US Air Force Test Pilot School, and he was a crew member of Expedition 64 and served as the International Space Station Systems flight engineer.

Christina Hammock Koch is an American engineer who launched into the. International Space Station as a flight engineer on Expedition 59 60 and 61.

On October the 18th, 2019, she and Jessica Meir were the first women to participate in an all female spacewalk to replace a down power control unit located on the outside of the ISS. And on December the 28th, 2019, she broke the record for the longest continuous time in space by a woman, and she returned back.

In February, 2020. And then finally we have Jeremy Roger Hansen, who is a Canadian astronaut fighter, pilot physicist, and former Aquanaut. He was selected as a mission specialist for Artemis two. He has commanded the Aquarius underwater base. He has worked on Capcom, which is the astronaut who talks the ISS astronauts when they're working through something and gives them lots of encouragement.

He's the first Canadian to go into space and he got a message from the king just before launch as well. It's nice, isn't it? Yes. Right. While we take a quick break and, when we come back, we've got some people with some questions for Rachel

Stars over Surrey, your Monthly Guide to Astronomy and Developments in Space. On Brooklands Radio.

And welcome back to Stars Over Surrey with Graham Laycock on Rachel Dutton as we cover this historic Artemis II mission.

Listener Q&A

And we've got some questions now from starting off with Thomas, who's aged 11. He says, **what speed is Artemis two going?** That's a good question. It is a good question. So it's got several different speeds.

So the first stage of the mission when it's in low Earth orbit, it's going at around 28,000 km/h. That's the same speed as the International Space Station. And that for people who prefer their imperial is 17,500 miles per hour. Goodness me! Might seem a really hard number to visualise.

So I've converted this into a new measurement. So I was thinking, what do people know? Jumbo jets. The 747. That's 31 times faster than a 747. Oh, well done. Well done. Right. So we've got a new unit of, A new unit, or measurement, makes a change from the size of a London bus, which is normally quoted on everything, isn't it?

Yes. And, we, we've got some other speeds as well. Um Oh, have you? Right. Go on then. Yeah. So trans lunar injections, so that's the burn that gets us away from the gravitational. Pull of the Earth that is 39,400 to 40,000 km/h which is 24,500 to 25,000 mph which is 44 times faster than a jumbo jet.

Luna Transfer is roughly 36,000 kmh, or 22 and half thousand mph. It's 40 times faster than a 747, and the reentry speed is approximately 25,000 miles per hour or 40,000 km per hour upon returning to the Earth atmosphere, which is again, 44 times faster than a jumbo jet.

And talking about funny measurements in space, when we look at radiation and the impacts on astronauts, instead of using things like CVE and graze between us, we often talk in banana doses. Right. And the overall tolerance that an astronaut can have to radiation the maximum upper limit, including all the testing and MRIs and x-rays they're going to be exposed to as an astronaut.

And incidentally, as a human being that might need medical procedures is one sievert that over the lifetime, right. That's. That's a really hard thing to sort of gauge because like one see it. So instead we look at banana doses. So that's the amount of potassium radiation in a banana. So sleeping in a bed next to someone overnight is half a banana dose.

Right. And yea we, we sort of work up to various different things like CT scans and x-rays. You get like 20,000 banana doses. Then when you start thinking about travel to Mars and you're talking in giga banana doses. So that's a fun fact about space medicine if you ever go into radiation research.

There we go. Alright., Amara aged eight. She says, **what food do astronauts eat?** Well, Graham, there is a whole menu that we've got to discuss. This is quite exciting. Wow. So food and space gets a bit complicated. It weighs a lot, so. They have to figure out how to make it as light as possible. so a lot of food is dehydrated and they add water back from the water that they have on space stations.

And in this case, they've carried potable water with them as well. you have to be super careful. You don't want anything too crumbly or where drops of oil will come and float off because if that gets into the electrics or anything like that, you can end up causing. Problems with the different systems.

So it might be, for example, the atmosphere or the lights or the heat or the, the pressure system. All those things that keep astronauts alive in space. So they have to be super careful how they eat. So they want food that kind of sticks to itself and is in one piece. So there are, three different types of foods.

You've got the ready to eat items that are consumed directly from their pattern,, packaging, sorry. You've got freeze dried foods that they can add water to, and then thermostabilised foods, which are heat processed for long storage. So tortillas are a favourite because you can wrap food in there. And unlike regular bread, they have less crumbs.

The problem is, and you may have noticed this when you fly, is that things taste more bland in space and we don't know if it's the sort of pressure changes on the ears and things like that, but airplane meals, they tend to add more salt and spices in, so it would taste different down on the ground, then up in the air.

I don't if you've noticed. I didn't realise that. No. The other thing as well is, the way that your sensors change in an airplane is things like crisps. Even though they're crispy, they actually, have the perception of being slightly soggy when you are in an airplane. And similar happens in space as well.

So food is very strange. There are many astronauts start to get into more spicy foods because they really want. Some kind of flavour. So I've got the menu. what happens is they get to try out all the different foods and they pick their favourites from that. And then on top of that, they've also got to have some nutritional balance as well to keep them in top tip shape, just in case something happens.

Because you've gotta keep them in prime shape once, once they're traveling. So we have. 58 tortillas. Seems a lot for 10 days, wheat flatbread, vegetable quiche, breakfast sausage, couscous with nuts, mango salad, that sounds quite nice. granola, which is like oats and nuts and things with blueberries. almonds and cashew.

That one surprised me because cashew nuts are explosive under pressure. And oh, they are shipped in shipping containers labeled as explosives, and they have to have explosive, packaging on them. Right. barbecued beef brisket. I've never had brisket, but I understand it's some kind of, meat,.

Things, sort of meats, sort of processed and put together, broccoli grata, which actually sounds really nice, broccoli with cheese, spicy green beans, macaroni and cheese, tropical fruit salad, butternut squash and cauliflower. They've got five different hot sauces that have flavour and the other flavourings they've got are maple syrup, chocolate spread, peanut butter, almond butter, spicy mustard, strawberry jam, honey, and cinnamon.

I'm not sure if any of this is appealing to you, Graham. Some of it is. It is making me a bit hungry actually. Yeah. for dessert they have cobbler, which. It's hard to explain to British people, but if you imagine like a fruit crumble, you've got the fruit bit and then. Some people have, more of a biscuit type topping.

Some people have a pastry type topping. Some people have a more cake like topping. Different people prepare it in different ways, and it, it's kind of like several different sort of circles of that on the top. And they have different textures and it kind of looks like cobbles, which is where then cobbler comes from.

It's one of those things that. In the US your grandma has like a couple of recipe. It's probably passed down the family. So they've got cobbler cake, cookies, chocolate and sugarcoated, almonds, and then to drink. They've got coffee, green tea, mango, peach, smoothie. And then this one confused me and I had to look it up a bit.

They have chocolate breakfast drink, vanilla breakfast drink and strawberry breakfast drink. But that is like a milkshake. But with all the nutrition stuff in it. So you know, you can do those diets that are milkshakes, but they've got all the nutrients you need in. Yes. Or sort of protein shakes that are a bit like milkshakes.

It's those so that they can top up the nutrients that they might not get with the other food. They've also got lemonade, apple cider, pineapple drink, and hot chocolate. Right. So, and how do they heat the food up? Do they have a microwave? They do have a heating system. I'm not entirely sure what it's like, but they can heat things up.

Right. It would look, it, it does look a bit like a microwave, but, I, I dunno the mechanics and the ins and outs from how that works. Mm-hmm. But after they've eaten, sorry, you gonna say

something else? That's okay. No, no, go. You go ahead. Okay. We've got another question coming up this time from anonymous.

I think I know why. The question is, after they've eaten all those things and drunk everything, **how do astronauts go to the toilet?** Yeah, so this has been a bit of a story in space history. the Apollo astronauts. They had, much less available to them. So they had for their number ones equipment that attached to them, and they had to pick whether small, medium or large would work.

And all of them opted for large. And this caused problems because that meant they had leakage, which was very unpleasant. So they had to relabel. Things from small, medium and large to large, humongous and gigantic and they picked the right size to attach to them, so that works.

That's number ones. Yep. Number twos in a bag like a bit like you put dog muck in and they actually left the, that on the Moon. Really? yeah. As rubbish because they were thinking there's nothing on the Moon. Yeah. Whatever. We don't wanna take, we want as less weight as you can when you're traveling through space, but back then we didn't know about.

You know, I'm sure you've heard about microbiome microbiota, the microbes in our gut, microbes in poop and people have feacal transfers and things like that. We didn't know about that. So now a lot of astrobiologists and space medicine researchers really want those samples back because they want to know if the microbes survived under radiation and what happened to them.

That's why we're going to the Moon again. Unfortunately, that's not in any of the missions that I've spotted. So anyway, that is the Apollo story. ISS different again, so ISS, they've got toilets on board. But for launch, they have enemas to prepare and then they essentially wear, what we would call a nappy or a diaper.

Think huggies pull-ups type things, but for adults, just so that that's something that they don't have to worry about whilst at the most dangerous point of their journey, which is launch and landing once on board. The ISS, they've got toilets. There's a toilet in Roscosmos. Roscosmos send all their waste back to Earth.

Now, everyone else, they eject their waste into space. So one of my favourite facts, I'd say favourite is kids that I do outreach. If you see the ISS overhead and there appears to be a shooting star coming out of it, that's not a shooting star you're wishing on. Right? It's all their rubbish, including astronaut poop.

Oh boy. Oh boy. All right. Now we know. Yes. And then finally. For the Artemis mission, they installed toilets now space toilets on the ISS and Artemis. On the surface of it kind of looked like a regular toilet but a bit smaller. you have to make sure you've got a good seal when you sit on them and there's a funnel system and yes, a pressure system to, because of the everything's where it needs to go.

Yeah. because of the weightlessness. Yeah. Yes.

Well, I have another question now. This is from Finley Age nine. Mm-hmm. And **what is the return date and how do they land?** Okay, so it's a 10 day mission and really hopefully they launched on the 1st of April. so they will hopefully land on the 10th of April. So interestingly, they're going to hit the Earth's atmosphere at.

25,000 miles per hour or 40,000 km per hour, and they're coming from the vacuum of space. The Earth's atmosphere has lots of gas in it, so that is going to cause friction and that will slow them right down to around 563 km per hour, or 326 miles per hour. So that is the actual crew speed of a jumbo jet, by the way.

So they're going from right. Like 44 times the speed to one time to the speed of a jumbo jet. But what's going to happen with all that friction is it's going to heat up the Orion module to temperatures of around 2,750 degrees C, which is about 5,000 degrees Fahrenheit. the sun's surface is 5,700 degrees kelvin, which is about twice that heat.

So those are incredible temperatures. So we're. We're glad that they sorted out the heat shield. what will happen is all that gas will become ionised plasma and it'll build up around the Orion module. So when they look out the window, they will see glowing flames. They know they're gonna see that. I can imagine it's still going to be very unsettling and unnerving to see.

And on top of that, that ionised plasma is going to block all communication for a few minutes. So they won't be able to communicate out. this is the most dangerous part of their journey. They'll have their pressure suits on, to help maintain all their sort of body temperatures and things. Should there be any.

Like tiny issues with the heat shield of the external bit. Once they've come through that they'll slow down, as I said, to the cruise speed of a jumbo jet. Then the final bit, they've got the 11 parachutes that will slow them right down. They're going to splash down in the Pacific Ocean. and they'll bob around.

There are pictures you can look online that will look like with life rafts and things, and a boat will come and fish them out, and then immediately on landing, they'll have their basic medical checks to check. There's nothing majorly wrong with any of them. Then they get to see their families, and then they have a few weeks of various tests and checks just to see for the sort of minor things that might have happened, if they had minor injuries or bruising on landing.

Um. The Soyuz when it lands on the Earth, even with all the parachutes, it's the equivalent of having a. Articulated lorry crashing into from behind. That's the pressure on the spine. It's not quite so bad on the ocean, but it's, it's still a lot. So they can still have bruising or sort of spinal problems.

They would've expanded a bit in space,, not as much as six months on the ISS, but you know, their bodies will expand and then they'll sort of come back together. A bit more again, so it can be a bit uncomfortable and getting used to gravity again. So they just keep a close eye on them for a couple of weeks before fully discharging them.

Right. Now Olivia, who's age 14, got a great ambition. She says, **how do I become an astronaut?** That's amazing. I am so pleased. There are more people wanting to be astronauts. Okay, so. The only sort of hard qualification that they look for is usually a master's degree or above in a STEM subject. And this is because you will be doing science experiments in space.

So even before we had a space station, when you had all the, the shuttles, they were doing science experiments on board. so you either need a science or engineering degree because you need to be trainable. In different scientific procedures, you need to understand the scientific method or you need to be good at engineering and be able to help maintain the atmosphere you're living in,, the module you're in, be able to do repairs and things like that.

So they look for a minimum of a master's in a STEM subject. Many have PhDs, but that tends to be the sort of global hard qualification that they want. Other than that. They are more looking at the person, their history and their personality. So you can imagine the amount of personality tests that airline pilots go through and.

This is that much, much more involved. They're looking for people who are great team players. That's one of the most important things. So things like someone who, played well in a sports team or in an orchestra or something like that. people who are calm under pressure. Someone who can face adversity and rather than get stressed, in a negative way, can work through those issues calmly and still be.

Polite and communicate what's going on to their team, to Capcom, to Houston or whoever they're talking to, on the ground, and they need to have good diplomacy skills. Every single astronaut I've met has been a really nice person, and I think that is by design because you're gonna be locked in an environment with someone, and that's something else you need to be okay with.

Being in very confined environments for long periods of time, you won't be able to feel the sun on your skin. Or the wind or anything like that. you have to be psychologically prepared for that, and you have to be able to get on with people all the time. languages, being able to pick up a language can be super beneficial.

Anyone who goes up in a EU must learn Russian. many people have pilot backgrounds. It's not essential. But again, it's really useful because you need to know how to pilot and steer things, especially on the dragon capsules or the Soyuz you need. Everyone if necessary, to be able to manoeuvre them around.

So any kind of that experience is really beneficial. So the main thing, science background and who you are as a person, you don't have to have like a stunning academic record if you read. Tim Peak's book, limitless. He's very humble and he talks about how he didn't have the best grades at school, but he just worked really hard.

Everything he did, and he got there through hard work and getting on with people and, you know, learning his craft at the various stages of his career as best as he could. So. People worry that, you know, they haven't got the, as the US would say, the 4.0 GPA or all a stars and the top grades and a first from Oxbridge.

They're not necessarily looking for that. They're looking for the skills and what you bring to the role. And you know, he showed that he can work hard and achieve extraordinary things despite not having the perfect grades and he is such a talented individual. So it's really the overall person that they're looking for.

Yeah, I can understand that. Now, Laura from Surrey says, **why do we want to establish bases on the Moon?** That's a really long question to answer, but the, the short version is one, as a staging post for further space exploration. Two, to carry out science experiments. we're looking at things like telescopes on the Moon.

But many other different experiments as well. One for further space travel, two medical experiments. So low gravity environments can help things, such as developing medications that have a more regular crystalline structure and they can be more effective for things than we can grow on Earth.

There's also in order to do things like cancer research, to grow tumour tissue on Earth takes a really long time, but it takes a couple of days under the radiation in space. so there's medical things that can go on. There's also all the spinoff technologies. All of us every day are using spinoff technologies from space and the astronomy industries, so all the satellites in space, obviously from space, but that contains your GPS, your computer, your car, your phone is using that GPS signal to determine its time.

Time and date, location, and all the software on it is looking at that information to run properly. communication equipment comes from space. Computers that are smaller comes from space. a lot of the coding comes from the space and astronomy industry. The ability to send information on what is now the internet actually comes from astronomy.

The smaller and smaller storage solutions for your data. So I was talking about the age of my laptop the other day 'cause the RAM is four gigabytes, which was big at the time. This is a really old laptop, which is still working really well. Four gigabytes is nothing now. All those improvements have come essentially from the space and astronomy industry and then taken by other technology companies and improved upon.

So every part of your everyday life is impacted by what has happened in space weather forecasting that is used for many things like farming, and the food you eat has come from space. So there is so much going on there as well as it would be nice to put boots on the ground, on the Moon, and. Conor. It's not just humans being, boastful and having hubris.

There is so much that we can learn from our space technology. Indeed. And, one more question, Ardip from Woking is saying, **what is the space economy?** Oh, that's a buzzword I've heard a lot

recently. Hmm. I've heard it too. Yeah. So. I mentioned this before with the ISS, that is a floating laboratory and it does have medical experiments on there.

Now we are getting more commercialised. You can imagine that some, drug companies and medical research will be paying for commercial space stations. To be doing this kind of research. Mm-hmm. And hopefully coming out with groundbreaking medications that could save thousands of lives on top of that, other things that you use every day.

So satellites, because GPS data transfer communications with people in other countries receiving television signals, potentially even those data Centres we were talking about before. Being in space, all those things that is the commercial space industry. And then there's lots of different sort of side, things that have come from that as well.

So the space economy is a huge topic, especially as more and more satellites are being launched into space by commercial companies. There are positives and negatives to that as an astronomer. There are positives and negatives to that as a human being living on the Earth. Hopefully we'll see more of the positives, but the one thing we're struggling with is that regulation, is not catching up with the rate at which technology is moving.

Summary

We've had some really good questions there, Rachel. And what an historic time this all is, isn't it? So,, it's not long now till they're around the back of the Moon and, then on the 10th they're landing again. They are, so I'm keeping everything crossed the rest of the mission. I hope they get all the observations that they intended to do.

I hope they have the most phenomenal experience and that,, they land safely back on Earth. Well, we'll have a, another update for you after they've,, landed. That'll be,, on Monday the 13th of April at 7:00 PM So we look forward to that. And, in the meantime, we wish them every success. So instead of happy star gazing.

Happy Artemis watching people Indeed. That's all from us, Graham Laycock and Rachel Dutton. And Clear Skies. Clear skies.

Stars over Surrey on Brooklands Radio. Join us on the last Tuesday, the month at 8:00 PM for the monthly guide to astronomy and developments in space.

At home. Instead, we're looking for local people with a kind heart to join our care team. You don't need previous experience, just a full driving license and access to your own vehicle. As you'll be supporting clients in their own homes. We'll give you all the training, guidance, and ongoing support you need.

About

Rachel Dutton FRAS is an astronomer and cellist and she looks after outreach at the Guildford Astronomical Society. She presents Stars Over Surrey bringing a monthly review of space news, astronomical matters including a review of the past month's discoveries, events and space missions, Astrocast what to look for in the night sky over the coming month, forthcoming talks and events.

If you want a reminder of when the show is on, and links to the images discussed, you can sign up here for notifications from Rachel.

Stars Over Surrey Previous Episodes