
And welcome along to this month's Stars Over Surrey. I'm Graham Laycock and I'm joined by Rachel Dutton from the Guildford Astronomical Society and a fellow of the Royal Astronomical Society. Hello, Rachel. Hi Graham, how are you? Alright, thank you very much, and you? I'm good, and I've had some really weird studies to read over the new year, so I'm quite excited to get into them.

**Is Dark Energy an Illusion?**

Oh, good, okay. Well, we'll go first of all then to astronomy, shall we? We shall. Okay, and understand that dark energy may not exist after all. Who's been keeping that secret? It's an interesting one actually. So let me talk to you about what dark energy is for anyone who doesn't know. When observing the universe and galaxies,  in the sky, Edwin Hubble noticed that they are moving away from us.

And the weird thing about it is not just that they're moving away, but they're moving away  at an increasing rate, so they're accelerating away from us. And that doesn't make any sense, because if you think of setting off a small explosion, like a bomb, you have all the energy, lots of movement at first, and then everything slowly settles down and stops moving over time.

And with the Big Bang model, you would kind of expect something similar. Big Bang, everything settles down and slows down over time. With me so far? Mmm, there you go, it seems logical to me. Great. So, that was considered a bit weird,  to start with, but then we were looking into it and I say, We, these are obviously cosmologists,  They worked out that something is causing the universe to expand and move away from us, but we can't see it.

We can't detect it. We don't know what it is. So we call it dark energy because dark, we can't see it. Yeah, can't see it, measure it, interact with it. We don't know what this energy is. It could be a force that we haven't discovered. It could be many things, but we don't know what it is. We, we call it that.

And,  there is someone who's won a Nobel Prize for calculating the rate of expansion called the Hubble constant. So it's quite a big thing that has been worked on for a long time. Now, some scientists were looking into this a bit more and thinking about it in a different way. We have an assumption that the universe is kind of broadly the same in all directions.

So obviously you have more mass when you look at a galaxy versus a dark patch in the sky, and you see things like these cosmic webs. But overall, if you would sort of take an average, it's kind of the same in all directions. We say that it's isotropic and homogeneous, but some researchers were thinking, well, actually.

Maybe you should go down to a slightly smaller scale, because we do have these voids, massive, massive voids of the scales that our brains just cannot comprehend. And we have areas where there are galaxies that are closer together, and areas where galaxies are further apart, and we're actually in a fairly quiet place.

We've got us, we've got the Triangulum Galaxy and the Andromeda Galaxy, and we've got Dwarf Galaxies, but there's not much going on around us. We're in a relatively quiet place. It seems to me if it's all accelerating away, they must be creating new voids. That could be the case. But then

these, these scientists were looking into it and thinking, well, actually, if you think about, do you remember the film Interstellar, you have Miller's planet where they go down for half an hour or an hour and the poor guy left in orbit has aged.

Yes. Right. So where you've got more mass and more gravity, time runs slower. than in areas where mass, where there's less mass, and therefore less gravity. And gravity is an effect of mass. So if you've got voids, you have less mass and less gravity interacting. So they are thinking, Where we have voids with less gravity, time is moving faster, and it appears that things are accelerating away at different speeds.

**Gaia Observatory Mission Is Over & How To Image A Telescope 1 Million Miles Away**

And now we're on to Gaia's mission is over. Yes. So Gaia does not get the credit that she deserves. Gaia was the original Lagrange 2 observatory way before JWST. She was launched on the 19th December 2013 and her mission finished on the 15th of January this year. So Gaia is a space telescope with a mission to map the motion of stars in the Milky Way.

And this has helped us to understand the physical and chemical makeup of the stars, build a detailed picture of the Milky Way, learn about the history of the Milky Way's formation, and that's quite funny because we have sort of merged with other large galaxies in the past, and one of them is nicknamed the Sausage Galaxy.

I wonder why that is? Because it's kind of this weird sausage shape. So there's been some great sort of galactic archaeology going on with the Gaia data. It's also helped us identify evidence of interactions with other galaxies. So people in the Southern Hemisphere, if you've heard of the large and small Magellanic clouds, those are dwarf galaxies interacting with us.

We've seen evidence of star formation in the Milky Way spiral arms. And Gaia's data is used. All over the world, not just by astronomers, but it's also used by space and satellite companies. it's used in communication technologies where you've got satellites trying to accurately pinpoint where they are in the sky, because thanks to this, as I've said before, gravity changes sort of time dilation as well.

A lot of people don't realise this, but the satellites that tell your phone where you are, because they are further away from gravity, they become less accurate by several hundred meters a day and they are constantly recalibrating themselves and some of them use the sky to recalibrate. Right. Which is mind boggling to a lot of people.

And also like astrophotographers, they use the Gaia data to help calibrate accurate colouring on their images where they want to do that. Now, Gaia's electronics, the sensors were built and tested by Mullard Space Science Laboratory. Now that's in Holmbury, St. Mary, which is nearby, and there's a team there that look after data from Gaia.

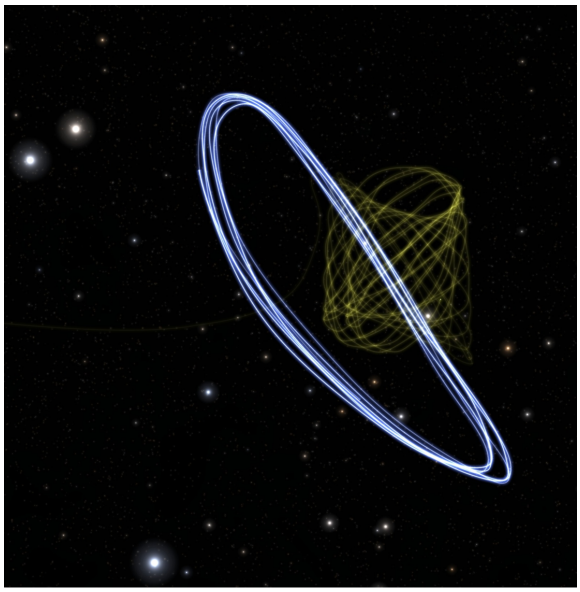
So this is sort of quite A personal mission to the area of Surrey, as well as the fact that it's really well known. So anyone that doesn't know MSSL, they're part of University College London, and they've been working on Gaia for like the last 17 years. So for some people, they've spent their whole career so far just on Gaia.

So, Gaia finishing her mission is not just, sad for a lot of astrophysicists around the world. I've had several people say, what do you mean it's finishing? I, I use Gaia all the time. It's a huge, huge landmark that her mission is finished. So, because they're local. they obviously know what's going on and you've got the team there who are very close to it.

They mentioned that Gaia is brightening due to engineering tests. And could we have a go at imaging her? I think, okay, that doesn't sound too hard, but looking at something that is a brightness and we measure brightness in magnitudes, this is magnitude 15. A comparison would be the James Webb Space Telescope is magnitude of 18, which is a bit fainter again.

Gaia's operating magnitude is 21, which is really faint. Mimas, which is the moon of Saturn, that kind of looks a bit like a Death Star, is also magnitude 15, so it's quite faint. You need a really

good telescope. So we're thinking, okay, so you've got this craft in Lagrange 2, which means it's the opposite side of the Earth to the Sun, hundreds of thousands of kilometres away, and it's got a diameter of 10 meters, I think I'd be wrong on that.



ESA/Gaia/DPAC; CC BY-SA 3.0 IGO

Um, and it's going around. I've got a picture of the two orbits to compare. So if you look in the notes, the white circular orbit, that's the James Webb orbit. In Lagrange 2, and that yellow one, that is the Gaia orbit path. Yes, I'm looking at it now. It is quite different, isn't it? Hmm, so that's called a Lissajous orbit.

Is it? And, yes, I'm going to put the picture in the show notes. So having a go at imaging that was going to be a challenge and there's several different ways to do it. So we have some pictures here that, some members of Guildford Astronomical Society have taken. So Tim, being the genius he is, and he's very humble about his abilities, he's very talented as an astrophotographer, he decided to have a go at imaging the James Webb Space Telescope.

And if you look at the next image I've sent you, you can just about make out this sort of streaky line that is the James Webb Space Telescope. And there is a second streaky thing, and that is actually an asteroid that he later identified. Right. Which asteroid it was. And method on this is you take lots of Exposures between sort of 10 and 30 seconds long each, depending on what kind of equipment you have.

Gaia Space Telescope (see the series of dots in a line) Credit: Tim Ellison

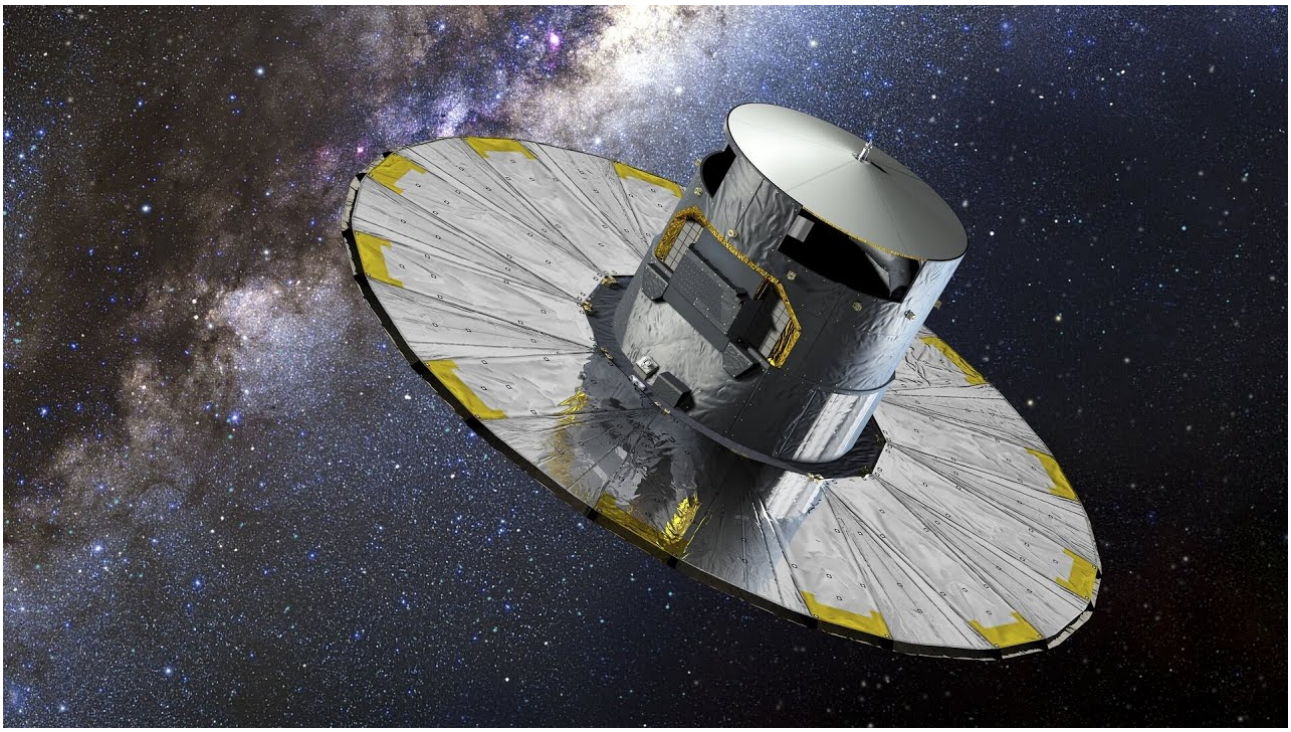
Faint streak is Gaia Credit: Rachel Dutton, FRAS

And then you sort of layer them on top of each other. So your stars will be super bright because you are getting more and more signal for those stars. And then you get this faint streak where the spacecraft is moving, or if you've got an asteroid where the asteroid is moving. And if you scroll down one more, you can see a beautiful picture he's taken.

And that streak in the middle. is the Gaia Observatory. Oh, yes, right. Which is a beautiful image. It is, isn't it? Yes. Amazing. Now, I had a go with my cheap little SmartScope. Right. And it's nowhere near as beautiful an image. But if you look to the next image, where Tim has very kindly circled it for me, you can see a little streak there, and I've also managed to image the Gaia.

Well done for doing that, yes. I was so happy because I was freezing doing that at midnight, but I'm really happy I've got that data. So that's, that's method one. I've also sent you a link to a YouTube video, which will go in the show notes. Yep. So there's a talented guy on YouTube called Adam Block, who has used a layering things,  he's instead created a video where you can see the movement of Gaia across the sky.

So if you'd like to take a look. Right, yes, I'm playing the video now. Ah, yes, and it's moving in a sort of an arc, isn't it? Yeah, my goodness. Yeah, isn't that amazing? It is isn't it being able to do that? Yeah Yeah, let's you see it move



https://www.youtube.com/watch?v=apFAuWmF_dA

Um, with the red circle around it so you can see what it is and then he shows it to you again without, so you can follow. Oh, I see. Yes, so you can see it without, you know, where to look in the sky. That was fascinating. It is. So that's two different ways to image a spacecraft several hundred thousand miles away from the Earth.

Yeah, the distance is so vast, isn't it? I know. It was mind blowing. So,  I had quite A visceral and emotional reaction when,  confirming that we had actually imaged them because you can't really see that you're doing it right. My telescope doesn't have coordinates, so I had to look up where those coordinates were in the sky, what was nearby, and then manually sort of slew it and hope. that I got something.

**Now we're on to Exocomet Belts.**

Yeah, so this is going to be a show heavily focused on comets. One thing that you would have thought would be pretty impossible to find would be comets because they're quite small little rocky space potatoes or icy space potatoes. And Comets have really crazy orbits.

They come from the far outer parts of the solar system, come in, whiz around the sun, and then go back out again.  but researchers managed to find exocomets. So what they were looking at is when these comets collide with each other or other objects, they then release a load of material, so grains of dust, that you can see in the radio regime.

So radio astronomers could sort of see these long tails. So they've been calling them exocomet belts. You can only see them from sort of particular angles. Now this might not seem terribly exciting, but comets are thought to be one of the things that could have delivered water to Earth and therefore comets might be essential for the chemistry needed for life to occur on various different planets.

So now we've got a whole research discipline of exocomets. belt, which doesn't sound that exciting, but actually it does mean that we might be able to figure out how Earth could form either in other solar systems, so not how Earth, but how life could form in other solar systems or the conditions for life more specifically, as well as potentially how they formed on the Earth.

Right, okay, so fascinating stuff then.  come in, show us other forces. Yes, so I said this is going to be a bit of a comet special. Yeah. So a researcher in California was looking at what are the different forces that can shape and influence our solar system and other solar systems. And actually comets provide a great example for most of these.

So we've talked about gravity. Gravity is By far the biggest shaping force, you know, you need things to collapse together under gravity to form stars and then later things to collapse under gravity to form planets and all the other things as well. People hear about the gravitational force of Jupiter can yank the sun slightly away from the center of the solar system, which it does.

And most people, if they're into space, have heard that Jupiter can fling asteroids around and capture asteroids. So, We know gravity is pretty much the big dominating force. However, there are other little forces going on as well that are quite interesting to look at. So, when a comet comes in from the outer solar system, we see it sublimating.

And this means that the heat from the sun, instead of melting the ice from solid to liquid, it melts it straight to gas, and this creates the coma around the comet, and it creates that big tail because the sun's pressure pushes the tail away from the comet. Also, when you get that, when that mass is sublimating off, it creates a recoil force similar to when you fire a gun.

And not only that, but there is also the torque from the mass loss on the comet itself. So he's been writing about different ways that we can have these different forces in the solar system. And you also have radiation pressure from the sun, which we don't talk about much, and that sort of blasts that comet tail backwards.

But if you've heard of solar sails, these are tiny, teeny tiny little craft that are being pushed outwards by the radiation pressure from the sun. So that was quite an interesting paper to read. Indeed, indeed.

**A Comet Becomes The Headless Ghost**

And comets become a headless ghost. Yeah. So I was pretty excited waiting for my next comet to image, and it was going to be Comet C 2024 G3 Atlas.

And it's been visible in the southern skies, and people have these. gorgeous landscape, astrophotography pictures of beautiful landscapes with this comet. So I was looking forward to moving towards the northern hemisphere so that I could eventually image it as well. Unfortunately, before it got to a place where I could image it, a Hungarian astronomer noticed, as it was coming more visible towards the latitudes, that The nucleus is broken up, so this is, this happens with comets sometimes, as they sublimate, they break up.

So instead of having that little neat head and the tail, it's now just going to have this tail that gets fainter and fainter and fainter, and will gradually fade, but with no sort of head or nucleus to it. And eventually, the debris left behind may or may not become a meteor shower in the future. Right.

**Planets Hiding In The Kepler Data**

Okay, now we're moving on to planets hiding in the Kepler data. We've mentioned before, actually, even with the Gaia data, people have gone back into and dug around and realised that with new analysis techniques and new ways of thinking about things, they can find things, haven't been found before.

And this is a similar story. So the Kepler mission was launched in 2009 and it was designed to monitor 150, 000 stars in a single patch of sky and look for exoplanets using a method called the transit method. Let's have a think about the transit method. Sounds really complicated, but it's actually quite a simple method.

So, if you have a light source and you wave your hand in front of it, that creates a shadow, and you're reducing the amount of light you can see from that light source. With me so far? I think so. Yeah. So, If you have a torch in the distance and a fly flies in front of it, then there is going to be a tiny reduction in light from that torch.

Yes. To the naked eye, you wouldn't spot that, but if you had a sensor, you would pick that up. And even a camera would be a sensor. Right. So. When you're imaging a star that's really far away, sometimes we spot these dips in brightness, which implies that something has passed in front of it. Now it could be that it has its own sort of sun spots or star spots, it's not our sun, and that could create a dimming.

It could be that something has passed between the observatory and that star, so it could be like an asteroid or something that's fairly close to the camera, so you'd get a dimming there. So what we look for are these dimmings, but also they have to be regular, and we call these light curves because you get the light detection on your graph and then you get a periodic Drop right so you get this curve pattern and that is called the transit method because the planet is Transiting in front of the star and you get this this dip and you have a regular orbit So that's what we're looking for regularity Yes, that is the key thing and where you get multiple planets you get multiple dips and you're looking for that proof that it is multiple dip in the same dip in brightness at the same period.

Yes. so all good fun. That's called the transit method of determining when you've got an exoplanet and you can work out things like the volume of the exoplanet based on that data. So Kepler was using the transit method and started finding lots of exoplanets like these hot Jupiters, which are these massive gas giants, very close to their star.

And then it found More and more planets, including, some that could be a bit more suitable for life on Earth. And it found 2, 600 exoplanets, which is a lot, because we started off with very few

at this point.  and they found some that were in the Goldilocks zone, which is the point at which you could have liquid.

Water on the planet's surface, if you're too close to the star, it's too hot, the water would evaporate away or sublimate away. Too far out, it would freeze. So you want someone with liquid water for life, as we understand it, but, you know, we only know about life on Earth. We want to try and find as many more exoplanets as we can to work out is there a possible possibility to have something that could have the right conditions and chemistry to create life.

So we obviously want to see if we can find more exoplanets. But two researchers in Hungary went into that data using new tools and analytical techniques and they found another seven exoplanets, which means that that data, like I said with the Gaia data, could be used over and over again. This data could be used over and over again to find even more exoplanets and hopefully ones that could show whether they have the conditions for life as we know and understand it.

And I guess the development of AI techniques will eventually enable data to be done much more quickly, analysis and so on. Yeah, and a lot of AI machine learning actually starts off in astronomy disciplines.

**Target of the Month - Planetary Parade**

Now, it's been in the news over the last week about all these planets lining up. Yes, so I've heard so many times, I've had so many questions about this planetary parade.

So There is actually a skin that you can get if you've got an iPhone, which has the current places of all the planets in the solar system. You can see Mercury moving around quite quickly. So at the moment, with the exception of Mercury, which is on the other side of the sun, but not for very long, all the planets are kind of bunched up in the same half of the solar system that we're in, so we can see them.

When we see planets in the sky, they move quite fast against the background of stars, in comparison, not as fast as the moon or the sun, but the plane at which they move along is called the ecliptic, so they're always going to be at the same sort of arc going across the sky, and the reason is if you Think in 3D, you've got the sun in the middle of the solar system.

And then if you imagine the sun being in the middle of the dinner plate and everything else is on an orbit around that sort of dinner plate. So you've got that disc and we've got a tilt. So everything is going to be within that sort of same line across our sky, which looks like this arc shape. So we call that the plane of the ecliptic.

It's got a very technical definition that I don't think people want to hear on the radio. But that's where we look for things. So you want to be facing south, you look for things rising in the east and going overhead and then setting in the west in this beautiful arc. Right. Okay, so we're just at a point in time where most of the planets are at some point in that arc, mostly at the same time.

But it's not just, it was I was given one date in January that was on one news website and then a week later another news website claimed it was this new date. The truth is they're pretty much on in the sky at pretty much the same time for most of February, as well as January. So if you go out in the evening, you'll see most of them having some realistic expectation about what you see is important.

So they're just going to look like stars, but are super bright. Mars is slightly red. I know roughly which ones I'm looking at because I know roughly where they are because I've been tracking them. You know, I track planets every time I go outside, so I roughly know which ones are which. But I know when something's a planet versus when it's a star because I know what stars should be in each constellation.

And my goodness me, what's that new blob? So for me, it's quite easy to pick them out. If you want to see them, I've decided this is going to be our target of the month. So we're kind of sliding

into that already. I recommend going out and having a look. You can go out into the evening if it's a clear sky.

I know we've had terrible skies recently. I do recommend if you don't have an app on your phone, this one is a good one to use an app for. You don't need to go somewhere too dark. Most of them are quite bright. Make sure whatever app you use that you calibrate it properly so your app can tell you where you are thanks to those satellites we talked about earlier that correct themselves but it doesn't always know what direction you're facing so you might need to calibrate it with the moon or look for a matching constellation and calibrate your app that way so do look how to do that.

Um, you should be able to see with the naked eye if it's a clear night you should be able to pick out Venus and Saturn towards the west, they'll set. within a couple of hours. You should then get sort of Jupiter and Mars, Mercury's the other side of the Sun, Uranus and Neptune you won't be able to pick up with the naked eye.

If you have a telescope or really good binoculars, you might just be able to pick those up as well. So that's the planetary parade. The other questions that I get, I get people asking, does it mean anything special? It is just one of those things that everything happened to fall into alignment, which will happen every few years, and then they'll fall out of sync again.

And then they'll fall sort of roughly a little bit back in sync every now and then. So there's nothing weird or cosmic going on, it's just one of those things, but it's pretty special to see. It's good fun, especially if you've got young astronomers to see if you can find them all in the sky. Yeah, indeed.

I guess what goes around comes around.

**And now on to our astronomy tip of the month.**

Yeah, so I mentioned this every now and then, the importance of logging your astronomy. With this planetary parade, it can make it a little bit more fun. So I have a screenshot that I've put here and I'll put it in the show notes of an app that I've created.

You can get it on your phone, and this is the desktop version which you pay a couple of pounds for. I actually do recommend paying a couple of pounds because it's very useful for planning your observing and your astronomy. And what you can do is print out Those constellations and make a map of your own so you can even draw the constellations and make a note of where the planets were in the sky each night you see them and you'll see them slowly moving across the plane of the ecliptic.

So if you do that over and over again. You will eventually get this nice little arc appearing in the sky. but it's also really good fun to sort of track where they all are over a period of time. And, if you've got kids, they often find it quite fun to do as well. So that's my tip of the month.

Logging your findings, you can draw, you can download an app, you can download a star chart and mark planetary movements across those. Right, well thank you for that Rachel. That's our look at astronomy this month. After the break we'll be back and we'll be in space.

Welcome back to Stars Over Surrey with Rachel Dutton and Graham Laycock. And now Rachel, we're off into space and there's been a few launches recently, hadn't there?

**Blue Origin New Glenn Rocket**

There has generally been super busy for launchers, so yeah, New Glenn, Blue Origin rocket, named after John Glenn, the first American into orbit, and the first American to orbit the Earth.

Um, it's designed to be reusable with around 25 uses. The idea to launch NASA payloads, telecom companies, equipment into space, as well as Project Kuiper. Project Kuiper is the alternative to Starlink. That's going to be Jeff Bezos's alternative. Yes, as an astronomer that

makes me sad because that's more things in the sky to avoid and to ruin my astrophotography, but that's a whole different rant.

But anyway, it's good they can get 25 uses. Yeah, it is pretty decent actually.  so, It's obviously looking to compete with SpaceX for affordable, reusable rockets, and it's good that people are considering reusability rather than once and done with our rockets, so that's great. Now Blue Origin use a different manufacturing approach to SpaceX.

So SpaceX,  use the agile, fail fast approach. So you just. You go live as soon as you can, you make a note of everything that failed, and then you fix that for the next time and you just keep going, keep going, keep going. It's almost like brute forcing it. So it's a bit like,  Saying if you want to sell cakes in a bakery, you're going to go for something that's Got some kind of cake sponge in it and some kind of decoration, but you have no idea what flavours people like or what kind of decoration people like.

So at first it might not be the most beautiful cake and the next one you'll try a different flavour and a different decoration. You just keep going and going and going until you hit on something that people like. So that's the Agile Fail Fast approach. Blue Origin have a very different approach and that's why it's taken them a while to get here.

They use the Waterfall approach. So this is everything is. Planned, meticulously tested to the nth degree before it makes it to the next stage. So the idea is that you're not just sort of building things, and then you have to scrap that because you've realised that the maths going a bit earlier was wrong.

Whereas, you know, Musk is happy for that to happen. He's like, let's just test the bits that we have that work. So both are reasonable approaches, as long as they're safety tested before you put people into them.  They're both very, very different. I'd be interested to see which is the more cost effective or cost efficient.

I would be interested in that data too. Yeah, now Blue Origin, a lot of people don't realise this, they were the first ones to successfully land a booster. They got there three months before SpaceX did. Oh, right. Yeah. So, but I think theirs was like the November and,  SpaceX was like the January, but the SpaceX one was more highly publicised.

Yes. So, at the moment, Blue Origin, their first stage booster is reusable and they're currently working on making a reusable second stage. And they have tested, and this is the waterfall approach, I said before you test everything before you move it on, they've tested their BE 4 methane engines twice in 2024 using the United Launch Alliance, or ULA's Vulcan rocket into orbit.

So instead of using the Atlas V, they replaced that with methane engines here. They've tested the engines on their own. In November we saw the whole stack being moved into Complex 36 in Cape Canaveral in Florida. So the fully stacked ship is 98 meters tall and that's The mass is 13,600 kilograms or 30,000 pounds.

Um, and then in January they did a hot fire test in situ, which is where they do a 24 second hot fire of the rockets be four engines in preparation for the expected test flight. So they've got all the data from that to know how it. The whole stack is going to work together. This was the first time they did a hot fire test with the first and second stage and ground systems.

So that's important to do next. And then the test flight was hit by a number of delays from a couple of systematic failures that they just weren't happy with and they wanted to get perfect. And then because this is reusable, not only did they have to look at the launch weather, but they had to look at the landing weather.

And the plan was that the booster would land on a barge out to sea that Jeff Bezos named after his mother, Jacqueline, which is quite sweet. I thought,  they were looking at the landing weather being right as well. So this is something else with reusable space rockets and something you think about when returning astronauts to Earth.

You need good weather for landing it, see if it's a dragon capsule rather than a Soyuz. But now we're looking at reusable things. You're not just looking at launch weather, you're looking at the landing weather for the bits that have to land. So anyway, after many, many delays and lots of people getting frustrated with seeing the timer reset to 30 minutes, they have eventually had liftoff on the 16th of January.

And watching the video It was pretty spectacular. It looked like it was moving really, really slowly. And the telemetry they had was all in imperial. So, Graham, I'm pretty sure you're probably more familiar with imperial than I am. So, but miles per hour, I can deal with that, I drive, but in feet. Oh, really?

Everything's in feet rather than meters. I think I'm right in saying the Americans are still using a lot of imperial. Yes. I was just shocked to see that. Because the international language of science and even, all the big engineering companies, they use standard international units. They use metric.

Yes. It's more sort of, a non professional thing to use imperial. So that was a big shock of most of us. they reached orbit though in 12. 5 minutes. So they've beaten SpaceX's Starship to orbit. So they've beaten them again. Starship has only done suborbital. but then they lost the telemetry with the booster, so they didn't manage to get the booster to land.

The getting something into orbit was the primary objective though, so it was a bit ambitious to try and get the booster to land at the same time, but they've hit the whole profile that they wanted for the mission, they're very happy, and well done Blue Origin. Well, well done to them. Well done to them.

**Starship Flight 7**

And then we had this Starship, Flight 7. Yes, which launched on the same day due to, again, looking at the weather conditions. That was the obviously optimal day. So they had a new block stack. This one was 52. 1 meters tall. So slightly bigger than the previous one. And they are back to having built the heaviest thing made by humans, weighing in at a massive, quite literally massive, 5 million kilograms or 11 million pounds.

Goodness me. I'm at this, the literal term, massive, lots of mass. The mission profile for Flight Test 7 was expected to be similar to the previous launch, targeting a splashdown in the Indian Ocean. And had the mission successfully entered its intended trans atmospheric Earth orbit, it would have attempted an in space engine relight and deployed.

Starlink simulators, which were expected to, re enter over the Indian Ocean. So, You're probably guessing from my wording that this didn't quite happen. It was also the first use of an upper stage that was an upgraded redesign of the avionics. There was an upgraded propulsion system and forward control flaps.

So, it mentioned before about the positioning of the flaps. Um. And their protection from heat, where we saw the Starship sort of belly flop on landing due to the damage of these flaps, so that was something that they had bore in mind at that point. And Ship 33's heat shield featured a next generation of protective tiles, as well as a backup layer of heat resistant material.

So again, this heat shield is really, really important. And SpaceX had removed some of those tiles so that they could sort of stress test. The heat shields and see how it performed. So that's the biggest issue that they're having, in my opinion. they're having other issues, but that's sort of a big blocker.

And also with the Artemis program, the heat shield is something that they need to look into a little bit more. So heat shields are big. topic at the moment. So that is something that they really want to make sure that they've got accurate. There was also another plan and this is pretty cool. NASA had planned to use a specially equipped Gulfstream V jet to capture images of Starship's re entry and peak heating.

And the aircraft was positioned to observe the spacecraft as it emerged over the horizon and splashed down into the Indian Ocean. And. There's like whole practices of this done. So the aircraft would have to fly with exterior and interior lights extinguished to ensure optimal imaging conditions. So thinking about light pollution when you do astrophotography, they were doing the same thing and this poses significant safety risks.

So they had to get waivers from aviation authorities. both in the U. S., but also they practiced this over Australia. So they had to get the same permission whilst they practiced this over Perth, Australia. And then they had to put in loads of stringent procedures to stop other aircraft from entering the flight path because they wouldn't be able to see them because they have no lights.

Right. Yes. Amazing. So a lot of work went into this particular launch,  so that they could. You know, trace everything and follow it back down. So, on the successful side of the mission, the booster was again successfully caught for the second time by the Chopstick Arms and the Mechazilla Tower. And if you haven't watched it, I highly recommend you look at on YouTube.

You see the booster, which is like a 22 story building, maneuvring itself, not just in a vertical position, but then sort of tilting itself to sort of go in and then lining up again. It's like watching a rocket do a parallel park in space. I know. Amazing. It's amazing thing to see. Yeah. It's just mind boggling because think how many people struggle to do that in a car.

It's that same sort of shape maneuvre. It's doing that sort of curve in. It's a parallel park into the, it's phenomenal and completely mind blowing to watch. So that did that successfully. On the less successful side, many people will have seen the images of Starship broken up over the islands of Turks and Caicos in the Caribbean.

So, they think that it had some kind of propellant leak or fuel leak that caused a fire in the aft section of the craft, causing a RUD, which is the new acronym for Elon's famous Rapid Unscheduled Disassembly, which caused this massive load of space debris. It looked pretty, it looked quite pretty on pictures, I have to say.

But Reuters did report flights were being diverted and the FAA also confirmed that,  they did have to sort of reroute people around the debris as it sort of started raining down. But this was communicated in advance on NOTAM, so notice to all, I think it's air personnel now,  telling them that That was something that could happen over the area.

Lots of pilots have said, yes, it was something that was communicated in advance,  people that did have to divert. It was done easily and professionally. So there wasn't at any point, any danger 20 flights, which is something I've seen speculated about online. So successful second. They've put a lot of infrastructure in place to,  hopefully watch the next test to see if they can see it come down, how the heat shield performs.

Because as I said, that's a really key piece of technology that we want to understand more. And if SpaceX can help with that, that will help the space program as well.

**Aborted Falcon 9 Launch After Aircraft Incursion**

Right. We move 18th of January now and the Falcon 9 launch, which was aborted. Yes, so I mentioned before about all these stringent procedures to ensure that planes are safe, but for some reason on the 18th of January, a Falcon 9 was due to launch from Vandenberg Space Force Base in California and it was aborted with 11 seconds to spare due to a plane being in the airspace.

Really? Yeah, there's lots of speculation as to which flight it was.  all the airlines are saying we followed all the procedures and instructions given to us.  and some amateur sleuths have gone online and found a number of planes that entered the restricted airspace. And,  there is a recording online of ATC telling one flight crew that they might get to see a spectacular launch ahead of them.

So that's still being investigated. Launch did happen a few days later, deploying more Starlinks. But after the beautiful demonstration of the safety,  aspects all planned out for that Starship launch, kind of felt like it was undone a little bit with that Falcon 9 launch abortion. Yes, indeed. Indeed.  now the Tesla Roadster masquerading as an asteroid.

**Tesla Roadster Masquerading As An Asteroid**

Yeah. Really? How did that happen? So,  funny story. The Minor Planet Center,  which is part of the Harvard Smithsonian Center for Astrophysics up in Cambridge, Massachusetts. They catalog all the asteroids we think we can find. There is a citizen science project in the Zooniverse platform that you can go on and help identify asteroids and potentially get them named after you.

Um, they heavily rely on citizen science. So it's Good fun to sort of dip in there, and it's not just about mapping asteroids for fun. We're also looking for near Earth objects, or NEOs, because these could be flung into motion by Jupiter or after colliding with something else, and then come on an Earth based trajectory and collide with the Earth.

So it is something we want to know about, even though we don't have planetary protection schemes in place yet, and we do monitor these.  but the problem is with asteroids coming close to the Earth, they're not reflective so they don't reflect light and they're dark, they're made of dark rocky material, so we don't see them until they're pretty close.

So, back on the 2nd of January, the Minor Planet Center announced asteroid 2018 CN41, a near Earth asteroid that was less than 150, 000 miles or 240, 000 kilometres away from the Earth. Now the Moon is 386, 000 kilometres away from the Earth, or 230, 000 miles. So this would be closer to the Earth than the Moon is.

Lots of red flags and warning bells at this point. However, it turned out a few hours later that several amateur and professional astronomers took a look at it and went, actually, that is Elon Musk's roadster car. So if anyone doesn't know this Elon Musk had his own personal Tesla Roadster, obviously, because he has that company too.

Um, and he decided to use it as a test payload for Falcon Heavy's first flight back on the 6th of February 2018. And included was a suited up mannequin called Starman. So, he launched that into space, and that's going into orbit, and that turns out to be the asteroid that they found. Oh dear, oh dear. There you go.

I thought it was crazy in the first place. So,  that was that for a bit of fun.  and that does show how amateur and professional astronomers, when they see anything weird at all, will collaborate together. And why it would be very difficult to hide aliens because we would all be chatting to each other trying to figure out what we're looking at if we saw anything weird.

**Bepi Columbo Final Mercury Fly By**

And now, it's a BepiColombo's sixth flyby of Mercury. Yes, so BepiColombo is the mission to Mercury that we've mentioned a few times, and back on the 8th of January, it passed Mercury for the sixth and final time, completing its final gravitational assist maneuver. So we use these maneuvers to either help spacecraft by sort of propelling them around in like a slingshot, or to use them as a brake.

So this one was being used as a break so that hopefully it can come back into orbit around Mercury next year. So as it did its flyby, it was a few hundred kilometres above the planet's north pole and it got some beautiful close up images to expose what we think are possibly deep ice craters whose floors are in permanent shadow.

And you can see these images. of these, planes. And this is on the night side of Mercury. And I think it kind of looks very similar to the moon. So, Graham, if you take a look It does. Yes, I'm looking now, actually. There's a whole row of them, isn't there? Four of them highlighted. Yeah, there are. And quite large.

Yes, they are. shapes. This is similar to when you look at the Terminator on the moon, that you get this exaggeration of shadows. So you can really get a feel for these crater shapes. Absolutely. Yeah. They're just on the boundary of the dark side, aren't they? Yeah. Yes. So that's kind of the Terminator and Mercury.

So I'll put those in the show notes again. So if anyone wants to see them, you can go to the stars over, sorry, Website page and there'll be a link to the show notes and you'll see as well. They're named after artists, which is the naming Convention that the iau have given to mercury So if you want to be a mercury creator, you have to be a famous writer artist or composer all right, and you need to have been famous for more than 50 years whilst you're alive and You need to have Died for more than three years before they named them after you.

So different planets then have different naming conventions. Yes, so Mars has got craters named after various different scientists. The moon's got craters named after very various different scientists moons of different planets You've got the planet is named after a roman or greek god We use the Roman names, but obviously the mythology is a bit intermingled and their moons are big characters in those lives.

So for example Mars, you have Phobos and Deimos who are the sons of Mars. and you can look at every planet and there's big characters within that mythological creature's life. However, Uranus, I don't know how many people know this, was originally named George's star after King George. Because Herschel, who discovered Uranus, the king at the time, William Herschel, in the UK, was King George.

So he named it after him, obviously, as you do. And all the moons of Uranus are actually different Shakespearean character names. Right. Interesting. I never realized that. Miranda, Uriel, all sorts of really interesting names on that one. Right, well thank you for your round up of what's been happening in space through January and now it's time for Astrocast.

**Astrocast**

Okay, so on the 1st of February the Moon is near Venus and Neptune. On the 5th we have the first quarter Moon which is the sort of waxing half Moon. On the 6th, we have the Moon near Jupiter. On the 7th, the Moon is near Mars. On the 12th, the full Moon is near Regulus. On the 19th, Venus is at its brightest.

On the 20th, we have the last quarter Moon, which is the waning half Moon. On the 21st, the Moon is near Antares. On the 25th, the Moon is near Saturn. And on the 28th, we have the new Moon. And as I mentioned before, pretty much all the planets are in the sky, except Mercury. which will reappear towards the end of the month.

**Events**

So it's a good month for planet spotting. Do you get your smartphone apps out to help you find them? Right now, let's go to a local events. What's happening during February. Okay. So on the 6th of February, Guildford Astronomical Society will have Dr. Chris Crow. a professional research astronomer with a PhD in astrophysics from Cambridge University, talking to us about a journey to the edge of the universe and back in time for tea, where we'll be exploring how astronomers measure the distance to the edge of the universe and hope to see even further with the next generation of space telescopes and how that view might change in the next 20 years and how far is the edge, why is it expanding and how far can we see?

Um, the Earth, like how far away can you go? And how large is our galaxy compared to others? Right, that sounds interesting, doesn't it? It does. On the 11th of February, Farnborough Astronomical Society has Steve Tonkin giving a talk on how to use binoculars, and why two eyes are better than one. binoculars do not get the credit they deserve.

I love using my binoculars. They're easy, they're lightweight, it's much easier than putting together a telescope. And with a few tips and tricks, and I showed someone the other day, how to speed up finding things in the sky with binoculars. They can be a really, really useful tool. On the 14th of

February, which happens to be my birthday, is Yule Astronomical Society's,  Neil Philipson is giving a talk on the new space race and the solar system, which will be pretty interesting.

And then on the 9th of February is National Astronomy Week in February 2025. And the theme is chasing the moon. We will be sending out a moon challenge for people to look at various different things on the moon within the Guilford Astronomical Society mailing list, so if you're not on that you can go to the website and figure out how to sign up there and We're also looking at holding an event at Newlands Corner towards the end of the month, so stay tuned for that as well.

Right, keep an eye out for that then. Well, Rachel, thank you so much for Stars Over Surrey for this month. Our next edition is on Tuesday the 25th of February at 8pm. So, all remains now to say goodbye to you and Rachel. Yes, hoping everyone gets some clear skies soon. Absolutely, so do I. And that was Rachel Dutton from the Guildford Astronomical Society and a Fellow of the Royal Astronomical Society.

**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.

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