[MUSIC PLAYING]

KAREN FOLEY: My next guest is Liam Steele. Liam, welcome to the studio. Now, you're interesting because you're a postdoctoral researcher at the Planetary Sciences group here at the Open University.

LIAM STEELE: Yeah.

KAREN FOLEY: Not many people know one, that there's postdoctoral research at the Open University or that there's even a Planetary Science group, which sounds very exciting. So can you tell us what you're doing?

LIAM STEELE: Yes. Well, my research is basically involved in the Martian atmosphere-- so anywhere from the present-day Martian atmosphere in terms of the water cycle, looking at just the way the circulation moves everything around, going back to looking at how Mars might have been millions or even billions of years ago to see if we can get a better idea of if it was possibly habitable all those years ago.

KAREN FOLEY: Now, you're doing something quite interesting because you've got a computer model. Lots of people have these models, which is a very nice way of studying things. So you've got this computer model of Mars's atmosphere, haven't you? Where do you keep that? Why haven't you brought it here?

LIAM STEELE: Unfortunately, it's just many thousands of lines of computer code. So it's not quite as nice to look at as a nice model of a spacecraft. But yeah, it's a model of the atmosphere similar to a model you might use for looking at the weather on the Earth. So you can run it. You can simulate lots of Mars years. You can look in detail at certain locations at certain times.

Or you can just run it for many, many, many, many years and just get an idea of what's going on, what's happening with the climate, because the one thing you can do with a spacecraft is that if you're looking at the surface, for example, the spacecraft could go around it and you could look at maybe seeing what the rocks are made of, what minerals are in the rocks. And as the spacecraft goes round and round and round, the rocks don't really change much so you can just build up a picture.

But because the atmosphere is dynamic, you can't really just take an observation and then expect that's what the atmosphere is like because a day later, an hour later, that's moved somewhere else. So we really need computer simulations to work out what's going on in the atmosphere.

KAREN FOLEY: And what you're going to do is get all of this data and then compare it to see how good, effectively, your model is.

LIAM STEELE: Yeah there's many ways we can use it. So one of the ways is just to verify that your computer model is correct because if you're running a computer simulation and saying, this might be what Mars is like millions of years ago or what it's like in the present day, you need to be able to compare it to something, some actual observation, to know it's correct.

So we can run it and then compare it with the observations from the Trace Gas Orbiter and see if what it gives is correct, in which case it gives you more of an idea that it is performing correctly. So you've got more idea that the other answers that you get out of it are correct.

And we can also put the observations from the spacecraft into the model and directly alter various variables in the model and that can help us to understand the observations. So if we detect a certain chemical in the atmosphere, we can add that into our computer model and try and work out where it came from, where it's going to-- what might have caused it.

KAREN FOLEY: Wow. Excellent. OK. Well, thank you for that. We're going to talk in a lot more detail about all of this but I'd just like to explain the widgets that are appearing on your screens. So we've got a few here. We would like to know in which year did we first confirm there was water on Mars. I bet everyone's going to go and google that and I bet everyone will get it right.

LIAM STEELE: No cheating.

KAREN FOLEY: No cheating allowed. Right. The next question's a bit more subjective. What speed-- although you could google it, as well. "What speeds can winds reach at the surface of Mars?" Then we're going to ask about the film. "In *The Martian,* the wind and the dust storm almost cause the ascent vehicle to blow over and an astronaut is blown away. Is this an accurate portrayal?"

And then, "Do you think we will ever detect life on Mars or evidence of past life?" So we've heard before that most of you don't think that there's life on Mars but let's see what you think right now because-- I don't know. Are we going to hope to change people's view on this?

LIAM STEELE: Yeah. We might, yeah. I always thought there was going to be hope that there might be life somewhere.

KAREN FOLEY: Yeah. So we were asking about current life but now we're looking at evidence of past life, aren't we? So it's slightly different. Then we've asked, "If all the water in the air above your head was turned into a liquid, it would form a layer of a few centimetres thick." So that's what would happen here. "If you did the same on Mars, roughly how deep would that layer of water be?" Bear in mind that water is obviously a very topical thing.

And then we've got three words or phrases to describe your thoughts about Mars atmospheric research. So like I said earlier and for those of you who have just joined, with these three options, if you can only think of one or two, just write a word in there and put an x by the other two and then you can submit those and they will be entered into our lovely word cloud.

Right. So we spoke a little bit earlier about why we're studying the atmosphere. And obviously, it's a vital component of a planet and the surface is obviously an important part. But you are more interested in things above the surface, luckily, at the moment. So can you tell us why you want to study the atmosphere and why it's so important for planetary scientists to understand what the atmosphere's doing?

LIAM STEELE: Yeah. Well, the atmosphere of any planet is a vitally important part because it helps shape what you see on the surface. It can help provide somewhere that's habitable for life because without an atmosphere, you're just going to get incredibly harmful UV radiation and all sorts coming to the surface.

And obviously, without an atmosphere, you can't really have any water on the surface or in the atmosphere, either. So you can't really consider the evolution of a planet or what it may have been like millions of years ago or even try to understand how it got to be the way it is today without taking into account what the atmosphere is doing. So it needs to be considered.

KAREN FOLEY: Yeah. No, absolutely. We've asked our audience certain things about the speeds at which winds can travel and I'd like to take a look at that one first. Most of them were saying quite fast, about 110%? How accurate is that?

LIAM STEELE: 110 miles an hour?

KAREN FOLEY: 110 miles an hour-- sorry. Yeah.

LIAM STEELE: At the surface, no, it's wrong.

KAREN FOLEY: Is it?

LIAM STEELE: Yeah.

KAREN FOLEY: So what do we know?

LIAM STEELE: The wind speeds were measured by the Viking landers in the '70s, I think, when they went and the average wind speed was about 15, 20 miles an hour but they can get up to about 60 miles an hour in a dust storm.

Really high up in the atmosphere, it's like where you would have jet streams on the Earth, which can help the airplanes come back from America quicker. On Mars, you can get wind speeds hundreds of miles an hour way up in the atmosphere. But at the surface, you're not looking at any more than 60 miles an hour, which is still quite fast.

KAREN FOLEY: No, it is. So then this film, *The Martian,* I guess, leading back, most people, 71%, have said that no, it's not an accurate portrayal.

LIAM STEELE: Yes.

KAREN FOLEY: They're clearly listening to you.

[LAUGHTER]

LIAM STEELE: Good.

KAREN FOLEY: So why was it important then to have something as dramatic as that, in terms of our interpretations of space? Do we not want things quiet?

LIAM STEELE: Yeah. Well, in terms of a film, I suppose-- because in reality, if you stood on Earth in a 60-mile-an-hour wind, it wouldn't be pleasant. You would get blown around. But because the atmosphere of Mars is so thin, I think a wind at 60 miles an hour on Mars is similar to an eight-mile-an-hour wind on the Earth. You would just feel a gentle breeze blowing past because the atmosphere is a lot thinner. There's hardly any molecules around so the force that they would impart on something as they hit into it, it wouldn't really affect it.

KAREN FOLEY: So it makes a good film, I suppose.

LIAM STEELE: Yeah. So if it was based on reality, then it wouldn't blow over. An astronaut wouldn't get blown away but there'd be no film, really. So I suppose in terms of that, it's just people want excitement. But it's exciting enough without having to make things up, I suppose.

KAREN FOLEY: This is the thing. It's like so many people associate studying planets with all sorts of interesting things and yet you guys all seem to sit here with your computer models and endless streams of data and numbers analysing and interpreting things. But equally, there is so much that is exciting, as well, about getting that data and interpreting it.

And in terms of what you're doing with the models and then predicting things, how important will that be then for the next mission, the second part of ExoMars, in terms of understanding how we can actually get the rover onto the surface?

LIAM STEELE: Yeah. Well, the atmosphere is important. Well, it's important in terms of if you want to put satellites into orbit around Mars and also getting landers or rovers down to the surface because obviously, if you want to send an orbiter to Mars and get into orbit, it needs to slow down from the speed it was approaching. And you can either use rocket fuel to slow it down, put the thrusters on and slow it down, but obviously, that adds expense for all the fuel. That adds weight to the spacecraft.

So what you can use is a technique called "aerobraking," where you actually use the atmosphere of the planet to slow the spacecraft down. So as it orbits Mars, it'll slightly dip through the upper atmosphere of Mars and the drag it experiences will slow it down. And it'll just keep doing that and going through the atmosphere. So it saves fuel but it takes a bit longer to get into orbit.

So the Trace Gas Orbiter, at the minute, it's got into Mars's capture orbit. And then I think from January until November next year, it's going to be doing aerobraking manoeuvres. So it'll slowly be moving through the atmosphere, which will slow its speed down until it gets to an orbit that's ideal for doing science operations. And as well, if you want to put something on the surface, then it needs to travel through the entire depth of the atmosphere at a high speed.

So you need to know a lot about how dense the atmosphere is, how hot the atmosphere is, how windy it is, how many molecules there are, if there's lots of dust particles flying around because at the speed it's travelling in, the dust particles can damage the spacecraft just by the speed they're hitting at. So you need to take all these things into account so that when they're building the spacecraft, they can build it so that it will survive the descent down to the surface.

KAREN FOLEY: Yeah, No, very, very complex, especially getting something so technically advanced and so small and robust to be able to get down there. So yours is a really, really important part of that whole overall journey. What do you think? I guess you know a lot about what you do already know. Is there anything you think that you don't know, any inkling that you've got about something that you think, oh, I'd be really interested in looking at that particular aspect of the atmosphere?

LIAM STEELE: Yeah. Well, in terms of the work I've been doing, which has mainly been focusing on Mars's water cycle, one of the things we really don't know at the minute is how much water has gone between the atmosphere and the subsurface to be trapped away because if Mars was once a lot warmer and wetter and now it seems quite dry, then where has all that water disappeared to?

There are some observations that show that there's buried reservoirs of possibly ice under the surface. And it's important to know how the atmosphere interacts between the subsurface and whether that water can be transported and stored safely. And if there's a lot of water underground, could that potentially be home for life buried underneath?

So that's something I would be interested in but it's very hard to work out what's going on under the surface because you can't really see it from space. You can vaguely see it if you drill down from a rover but it's with atmospheric models that you can do all the physics and work things out and run simulations for millions and billions and billions of years and try and get an idea of what might be happening deep underground.

KAREN FOLEY: So on to the subject of water then, 71% of our audience said that 2003 was the year that we first confirmed there was water on Mars. Are they right?

LIAM STEELE: No.

KAREN FOLEY: Ah. So tell us.

LIAM STEELE: It was 1963 when-- who was it? Somebody took obser-- Spinrad took observations with a telescope on the Earth and determined by looking at the spectra that he got back that there must be water in the atmosphere of Mars. So that was the first confirmation that there was water in Mars but that was atmospheric water.

And I think it was in the early '70s when we actually finally confirmed the ice caps. We haven't got an image of them but the ice caps on Mars were composed of water ice, as well. So it's still fairly recently. It's the '60s and '70s but not as recently as 2003. But still--

KAREN FOLEY: But I guess this is all developing so fast. Time in planetary science must just seem so immediate. Every year, you're having so much stuff that's outdated. By the time you actually launch something, you've probably got technology that supersedes that.

LIAM STEELE: Yeah. So the amount of time and planning that goes into building it-- so that by the time it gets into orbit and taken there, the technology that's on it could be 10, 15 years behind. But that's just unfortunately the way it goes.

KAREN FOLEY: OK. Well, at least you're not all googling everything. Well done.

LIAM STEELE: Yes, that's nice to know.

KAREN FOLEY: So we asked also about the water over your head if it's turned into liquid. 74% said 1/100 of a millimetre, followed by 14% who said a millimetre. So this whole idea then of having water, how thick that layer would be, what's the situation there?

LIAM STEELE: Yeah. So as I say, on Earth, if all of the water that exists as a vapour and clouds and things, we grabbed it all and shoved it onto the surface as a liquid, it would be maybe a few centimetres-- maybe a few inches thick. But on Mars, it is typically about 1/100 of a millimetre, which just shows how little water there actually is. Even though there's ice caps on the surface and during the summer, the ice caps sublime away and transport water, but there's still-- it's a fraction of the amount of water that you get on the Earth.

But it can still have interesting effects on the atmosphere because the atmosphere is really thin. So less water can still have an effect but it's quite a small amount.

KAREN FOLEY: Well done, you at home, and I trust you didn't google that. HJ.

HJ: I think Ian has a great question, probably something that we're all thinking and this is probably one of these big questions that always comes about when we talk about Mars. And Ian would like to know, "Would it be realistically possible to terraform the surface of Mars to make it habitable for human life? And are there ways to make an Earth-like environment on Mars?" So will we be on Mars in 10, 20 years maybe or does it take that long or can we even do it?

LIAM STEELE: There is definitely-- there always has been for a while plans to send humans to Mars and to have a colony that live there. Initially, it would have to be living within some sort of dorm or some sort of something on the surface. Anyways, you couldn't just live outside because it's

95% CO_2. It's not a pleasant atmosphere to live in.

And there has just been for tens, 20-- for lots , not hundreds-- many years, there's been talk about, could you terraform Mars and release oxygen to the atmosphere and create somewhere that'd be nice? I think technically, it is possible. Whether anyone would do it, though, I have no idea. And the complexities of actually being able to do it would be quite large.

KAREN FOLEY: And if the weather's not great there, to be honest, I'm not sure I might as well be even interested, especially not with these dust storms.

LIAM STEELE: Well, yes, it's dust storms. It's freezing cold. You have to do quite a lot to the atmosphere to get it into a pleasant place for people to live. But technology changes so quickly that maybe in 50, 100 years' time, that might be possible.

KAREN FOLEY: So never say never.

LIAM STEELE: Yeah.

KAREN FOLEY: Right. So we've got talked about methane and we've talked about water and the importance of those and the importance, I guess, of tracing whether or not some of those are there and then thinking about what the implications are. We also talked very briefly about Mars's past climate and we've talked earlier about whether or not we could find fossils there and what we knew about the past.

And atmosphere is obviously something that, as you say, changes almost instantaneously, as well as obviously over a longer period of time. So why is that past climate important and how does that then figure in your model, which you seem to be talking about in terms of the future and predicting things? What about the past?

LIAM STEELE: Yeah. It's definitely-- if you want to consider if life could have existed on Mars billions of years ago, then you have to take into account the atmosphere. One important thing it does on the Earth is there's the ozone layer, which stops UV radiation getting to the surface. Mars in the present day doesn't really have very much of an ozone layer. So UV just goes straight down to the surface.

So in the present day, unless you were underground or protected by some big thick ice cover, then I think the UV radiation would just kill any microbes off. But when you look at Mars in the present day, geologically-- which there'll probably be more talk about later on-- there's evidence for things that look like river valleys, channels, gullies-- the fact that the northern hemisphere of Mars seems quite flat compared to the southern hemisphere.

People have hypothesised that there might have been an ocean covering the entire northern hemisphere of Mars. And even in some of the craters that you see now, there's little river valleys and channels that run down into the crater. So it looks like the water could have around and then pooled into the craters. So that all points to Mars having liquid water flowing on its surface for quite a long time to carve out a channel.

KAREN FOLEY: And they seemingly calculated that Mars may have lost as much atmosphere as the Earth currently has.

LIAM STEELE: Yeah, because at the moment, water isn't very stable on Mars. It's really cold. There's not much atmosphere. But the geology of Mars makes it look like it was warm, wet-- quite nice. So you have to take into account how was that possible, which can only have been possible if the atmosphere was really thick and had a lot of cloud and had a lot of other greenhouse gases that could have warmed the surface of Mars up and then trying to work out why did it all go wrong for Mars and why did it go from a really nice place a few billion years ago to somewhere that's hospitable now.

KAREN FOLEY: What a tale of woe, Liam.

LIAM STEELE: Yeah.

KAREN FOLEY: Don't worry. Thank you very much for joining us. It's been really, really interesting and I really hope you get some good data. And I hope your model's relatively robust and that you also find some interesting things to add to that picture, as well. So we'll look forward to catching up on that later. But Liam Steele, thank you very much for joining me today.

LIAM STEELE: No problem.

KAREN FOLEY: Right. Sophie and HJ, before we welcome Rhian to talk about the Schiaparelli Lander, which we're also excited about, how's everything going there and do we have any other questions? I know there were some questions for Rhian also but what are you all talking about right now?

HJ: I think Simon and Davin are very interested in how the computer programming works. And Davin's using a lot of words like "C++" and "Python" and things like that which I have no idea about. But perhaps some of our guests have been popping in and out in the Chat and they can answer those very technical questions.

SOPHIE: Jan's also in the Chat, as well. He's doing really well to keep on track of everyone's questions. So bear with us. And if we don't get back to you, Jan, at least will. He is getting there, bless him. So there are lots of Rhian's questions about but we also like the chat that we're having about all the things that could happen in the future with space and the wormholes and the loopholes to Mars. And we still need to arrange our SHL space trip to Mars, actually. I'm pretty sure that was the last--

HJ: We should do that. Who's aboard for our SHL spaceship trial? Let's do that.

SOPHIE: We need to get that sorted.

HJ: Yeah, we'll do that-- perhaps a day trip.

KAREN FOLEY: Where did you get to last time with all of that?

SOPHIE: Not as far as I'd hoped.

HJ: No.

SOPHIE: This chat's making it more like we might actually get there. We would have to get our guests together and see if they can give us any advice on how we can get there.

HJ: What clothing might be required, that type of thing--

SOPHIE: Definitely.

HJ: Yes.

SOPHIE: Next time-- I'll get started on a little model for next time.

KAREN FOLEY: Excellent. Oh, that's really, really good and great to see you all chatting. I'm glad you like the set, by the way, and the stars. Wonderful, isn't it? In fact, the whole idea of space is appealing to me a lot more, especially being in such a wonderful environment. So I'm glad you're all happy out there. I'm glad you're all chatting.

Do let us have your questions. Do let us see your cloud pictures. Send in your selfies and we're going to get some of those through really soon so we can see where you are and what you're doing, et cetera. It's really nice to see who's out there.

And you can also add your picture to your profile actually, as well. So if you want to add your picture so it appears in the Chat, you can just go to your profile and select a picture there that you like or that's reminiscent of you and add that so that other people can see who you are, too.

[MUSIC PLAYING]