



Planet Hunting: You Don't Need a License (or PhD) with Dr. Michelle Kunimoto

Nerdin' About Podcast Transcript, Season 1 Episode 10

Michael

Hey everyone, welcome in Nerdin' About! I'm Space Michael, and with me as always is Dr. Kaylee Byers who as we heard from last episode, seven years for a postdoc, also seven years of Buffy, which has got me really confused, because I just finished Season 2, and Buffy has just killed an Angel, and she's took off on a bus. So, the show should be over. Right?

Kaylee

You know what, it can all be very confusing, especially because apparently, I just went from seven years in a PhD, to seven years in a postdoc? Buffy is going to take you on some ups and downs. I don't want to give too many things away, but at least you know you're in it for the long haul now.

Michael

The long hole, like the Hellmouth even.

Kaylee

Here we are talking about holes on Earth, but of course they can also exist in space, and today, we're going to be talking about space. Today we're joined by newly doctored Michelle Kunimoto, who is an exoplanetologist, and recent PhD graduate at the University of British Columbia, and is just sitting around waiting for a postdoc at MIT, where she'll be working for NASA's TESS mission (Transiting Exoplanet Survey Satellite) to discover and characterize new planets outside of the solar system. Hello, Michelle, thank you so much for joining us today.

Michelle

Thanks for having me.

Kaylee

This episode is just like Michael's absolute dream. I'm more of a space newbie, but for us people who tend to study the things here on planet Earth, maybe can you tell us what an exoplanet is?

Michelle

Sure. So, an exoplanet is a planet that's outside of the solar system. Exo means outer. So, you know, if you've ever watched science fiction, and they're on another planet, it's probably going to be an exoplanet.

Kaylee

So, it's outside of the solar system. So, I would imagine those are pretty hard to find considering we're in this one. So how do you find yourself in a place where you can actually say that you've discovered 21 of them?



Michelle

Yeah, you're totally right, it's pretty hard to find them. All the planets in our own solar system are so close, relative to everything else in space, that you can use a backyard telescope to see a lot of them with your own eyes. Exoplanets are so far away that you need to have special techniques, and sometimes, telescopes are needing to be on the cutting edge of technology to even be able to see the signal from an exoplanet.

Michael

So, Michelle, you've discovered some of these exoplanets, and you say that you can't just use backyard telescopes. So how do you find them?

Michelle

Typically, you're going to need a really high precision telescope like one that's either in a big observatory on the ground, or the one that I used, which was data from NASA's Kepler mission. So, Kepler was the first telescope that was actually able to find small Earth-sized planets orbiting around sun-like stars. All of their data is actually available for free on the internet. Anyone with an internet connection, and a computer can just go on there, and see all the data that was taken by Kepler. So, for my undergraduate degree, and then my PhD, I downloaded all this data and searched through it to find new exoplanets.

Michael

Now, is that a normal thing? Are other grad students doing this? Or is this something that you kind of took on and was like, I'm really excited about finding alien worlds. I'm going to take this on and try to see if I can find some?

Michelle

There have actually been high school students that have done something similar to what I did. It's actually really accessible, and there's a lot of online resources for people to get started with planet hunting. So, yea, high school students, undergrads, graduate students, or anyone really, you don't need a PhD to be able to join the hunt for exoplanets.

Kaylee

I mean, I have a PhD in rats, but that did get me very excited that maybe I could find one too. So, what are the characteristics? When I download the data, what am I looking for?

Michelle

The basic idea behind finding planets with Kepler is using what's known as the transit method. So anytime an object passes in front of a light source like a star, it'll block some of that star's light. So, the idea behind this is you're observing the star and you're measuring the brightness of the star over time, and anytime the stars' brightness dips, it's probably a planet that's passing in front of it, and blocking the light from that star. So, if that happens periodically, it's a really good indication it's a planet that's in orbit around that star.



Michael

So, you talked about the Kepler mission, and you're also going to be working on the TESS mission. Could you maybe talk about those two telescopes? Are they the same, or what's different about them?

Michelle

So, Kepler, as I mentioned, it was the first really high precision telescope that could find Earth-sized planets, and it looked at a single section of the sky in the Cygnus and Lyra constellations. So, if you were to hold your hand out at arm's length, the amount of space that that covers is actually about the size of the sky that Kepler was able to observe. TESS is very different in that it's actually going to be looking at the entire sky, rather than a single section, it'll be looking at all the nearest and brightest stars for exoplanets.

Kaylee

So that seems to me, as a rat scientist, to be a big glow up, to go from one section of the sky to the whole sky. How do you do that? What's so different that allows TESS to be able to look at such a greater area?

Michelle

Well, there's advantages and disadvantages of both procedures. So, with Kepler, they wanted to have a lot of stars that had very little background that's getting in the way that could contaminate your measurements. So, the section of the sky they chose was specifically a section that had very few background stars that could do any kind of contamination, whereas TESS is going to be looking at really bright stars, which are easier to observe. The downside of that is that there's going to be more contamination due to other sources that are in the same pixels.

Kaylee

What other things would contaminate?

Michelle

Mainly stars, but the really important thing about TESS too is that because it's observing really near and bright stars, it's going to be more conducive to follow up measurements from other kinds of telescopes, like those on Earth that don't have the precision to be able to follow up on planets found by Kepler, but would with TESS.

Michael

So let's take us back here, Michelle. So, you were an undergrad at UBC, and you're studying about space, how is it that you yourself found yourself in a place where all of a sudden, you're discovering exoplanets? Like it just seems like a big jump, you're in school you're studying, and then all of a sudden, you're making these huge discoveries. When I was going to school, there were zero exoplanets discovered like that seems like were you just in the right place at the right time, and it was just something that you jumped onto?

Michelle

Yeah, I think that's it, I do feel really, genuinely lucky about where I am. So as an undergrad, I actually didn't have any research experience until the last year of my undergrad, and there's a program at UBC



called co-op, where students can apply for jobs in the field that they're interested in, and try to get research experience, and I was actually not successful at getting any jobs. But I took a course in my third year called exoplanets and astrobiology, and that was actually the first time I'd ever learned about exoplanets, how to find them, and the potential for life on other planets outside of the realm of science fiction. After that course was finished, I basically went and talked to the prof and said, "You know, I'm looking for any research experience that you can provide, if it's possible that you'd be able to provide like an internship over the summertime. I'm really interested, please let me know." There was a research award that was given out to undergrads, specifically undergrads that are looking for their first research experience, so I applied for that, and he became the supervisor for that.

Kaylee

What excites you about doing this work? Why did learning about exoplanets make you decide that that's the sort of research that you want to be doing? What is it about this field that gets you excited?

Michelle

Well, I'm a huge Trekkie. The original series is what inspired me to go into astronomy in the first place. I think in the original series, it's a very cerebral show, like it's not all action, and good versus evil, there's a lot of philosophy, and they seek out new worlds, civilizations, and I think that really instilled a sense of curiosity in me. At the same time, the possibility of life on another planet is something that I think everyone has asked themselves at some point in their lives, you know, are we alone? That's such a fundamental scientific, and philosophical question, and by looking for exoplanets, I feel like I'm starting to be able to answer that question, especially looking for potentially habitable planets that could look just like our own Earth.

Kaylee

Have you found any that sort of fit those characteristics?

Michelle

So, I did find one that fits those characteristics through the dissertation. So, my PhD basically took the search that I did as an undergrad, which was on around 400 stars, and expanded it to the entire Kepler data set of 200,000. I basically did just what Kepler did, where they searched those 200,000 stars but tried to find anything they'd missed. Out of that came 17 new planet candidates, one of which is what I would consider a rocky planet. So that's going to be smaller than about 1.5 times the size of the Earth, and also in the star's habitable zone, which is a range of distances from a star where it could have liquid water on its surface. So even though we don't know a lot about the characteristics of this planet specifically other than how big its orbit is, and its size, we can start to estimate, you know how hot that planet might be depending on different assumptions.

Michael

As we talk about the habitable zone, maybe expand on that? So, are you really looking for Earth 2.0? Are you looking for all of the same characteristics? If life arose here on this planet, do we have to find another planet like ours in order to find life?



Michelle

Yes. So, this is one of the fundamental questions that astronomy is trying to answer. Just how common other planets like Earth are, and what exactly it means to be like our own Earth is a pretty controversial question. You know, does it have to be around a star just like our Sun? Or can it be around a star that's hotter than our Sun, or cooler? Does it have to be a planet that's exactly Earth size? Or can it be a little bit bigger? A little bit smaller? How does that change the prospects for habitability on that planet? We also have to make a lot of assumptions, because we're very Earth-centric in our estimates, we assume that life's going to need water, we assume that life is going to need a rocky planet to live on. The more and more we discover I think the more we can actually start to challenge those assumptions.

Kaylee

It must be very hard to even try to think about what something like a Earth would look like if it didn't look like Earth.

Michelle

Exactly. There's a really big push right now in the field to start to look more at M dwarfs, which are stars that are cooler and smaller than our own Sun, and the reason for this is because they constitute about 70% of all the stars in our galaxy. So, any planets around them are going to be really common, and the planets that are in the habitable zones of these stars orbit a lot closer to the stars, because they are so much cooler than our Sun, which makes them easier to find. So, these are really good things to think about when looking for these kinds of planets, but the downside is if they are so much closer, they're going to be bombarded by so much more radiation than we are on our own Earth. We really don't know what that means for habitability, because we're the one data point of a planet that is able to support life and, there's so much more that could be possible.

Michael

So, what do you think that one data point is going to be? Quite often, I see articles that come out, and it's astronomers who find the next Earth-like planet, and everyone gets excited, but it's not really what they're looking for. Because we're talking about aliens. We're talking about life, and we have all these ideas because as you said, you're a Trekkie, and we kind of have these visions in our head of what that looks like. So, what is that data point that you're ultimately hoping to find? That's going to be able to say, okay, yes, we have found this planet that has a really good chance of sustaining life.

Michelle

I don't think we're there yet technologically speaking. I think there is actually going to be in the next decade or so, really big advancements in finding atmospheres around other planets. So, at the moment, we can characterize the atmospheres of really giant planets like Jupiter-sized planets, but we haven't been able to do that for Earth-sized planets. So, if we can find water in an Earth-sized planet's atmosphere, that would be a really good sign for habitability. There's also the field of astrobiology, which is trying to figure out if there are particular bioindicators that if these molecules exist in a planet's atmosphere, only a biotic process could have caused those. For instance, methane, carbon dioxide, oxygen, you know, is there a certain combination of those that could actually indicate you have life on this planet's surface? So



again, we're not quite there yet to be able to detect those molecules in such a small planet's atmosphere, but we are going to be there I think in the next 10 years or so.

Kaylee

Even if we discover, say, Earth-like planets, should we all be packing our bags, and getting ready to go on a vacation? Like how long would it take to get there?

Michelle

I mean, a lot of the planets found by Kepler are thousands of light years away. So even if we were traveling at the speed of light it would take thousands of years. That being said, I think if I had a favorite planet, it would be the one that is around Proxima Centauri, which is the closest star to our Sun, only 4.2 light years away, so relatively close, and is actually in the habitable zone of that star. So just the fact that the closest star to our Sun has a planet in the habitable zone kind of shocks you into thinking, well, geez, how common are potentially habitable planets in the galaxy?

Kaylee

Yeah, and how many organisms, life forms are looking at themselves, and also thinking they're just one data point.

Michelle

Yeah, exactly.

Michael

You know actually just got me thinking, you know Kaylee you study rats, and you're able to like to burrow in there, and actually touch them, and interact with them.

Kaylee

Oh, too many of them.

Michael

But Michelle, you know, I can imagine you're going to have a long career, I mean, you're already well on your way, but you could reach the end of your life, and you will not have answered some of those big questions, or even come close to some of those big questions. Where does that leave you as a scientist in that drive, that quest, to try to answer those questions?

Michelle

Well, I think there's a quote, "we stand on the shoulders of giants", you know that the big advancements of the future are possible because of what people are doing right now. So that's developing new techniques to find exoplanets, developing the technology to find them. So, even though we probably won't be able to say if any of the planets discovered in my lifetime are actually habitable, just being able to find so many planets now, and start to understand how common they are really helps the future to plan new missions, and design new missions.



Michael

Then they'll be able to say that the Kunimoto planet, which you discovered but didn't know that it had life, but in like 500 years, they've found life.

Kaylee

Speaking of sort of standing on giants, and into the future, and also thinking of Star Trek. Is there a planet from Star Trek that you would love to find actually existed?

Michelle

Well, it's funny you say that because a lot of people like to ask me what I would name the planets that I found, and they're given very technical names just based off the star, it's all very technical classification, but privately I can name planets. So, what I've done in the past is look at planets from science fiction, and if there's any estimates of what the star that they orbit around, like Vulcan, for instance, I think the Star Trek wiki has estimates of what kind of planet Vulcan would be like what star it orbits around. So, if I ever find a match to Vulcan, I'd love to be able to privately name that Vulcan. I think there's another planet that in the media is often referred to as Hoth, because it's an ice planet, things like that I really like.

Michael

Speaking of your life, as a scientist, Michelle, you are leaving UBC, you're going to be starting work at MIT. As you said, you're going to be switching from working off of Kepler data to now TESS data. So how does your work change? Or is it going to change at all? Or is it just sort of a continuation of what you did as an undergrad?

Michelle

It will be a bit of both. Obviously, I'll be able to draw on a lot of my experiences using Kepler data, designing my own pipeline to be searching through that data, and assessing the candidacy of new planets. TESS is going to be a little bit different. There'll be different systematics in the data, different things we'll have to be careful of, and one thing I'm actually really excited about is, as an undergrad and PhD student, I've been working pretty much all by myself with my supervisor, but no team of scientists, no group, it has just been me and my computer. Whereas with TESS, I'll be working with a whole team of programmers, and astronomers, and scientists. I was the only grad student who was working on exoplanets at UBC. So, to be able to actually have people across the hall I can just gush about exoplanets with I think will be really, really nice.

Michael

It's like kind of like when I was in my parent's basement, and I had my Star Trek uniform on, and I had like nobody to talk to and all of a sudden, I moved to the city and I was like, Oh, wait, there's other people that like Star Trek too? Awesome.

Kaylee

You needed the holodeck. You needed the internet, a long time ago to be able to meet those people.



Michael

That's right, and as we've talked before, I did not have the internet when I was in the suburbs. Should we get to some nerd herd questions?

Kaylee

Oh yes.

Michael

All right, so if you're interested in asking a nerd herd question, Kaylee and I as we get our stuff together, we'll post things on our social media @NerdNiteYVR on Instagram, Twitter and Facebook. So just like we're interviewing Michelle we'll post so if you ever want to ask a question, make sure to look out on those social media platforms. Previous guest Pramodh gets in with the first question who asks, "Which exoplanet is most likely to be a tourist destination for future human beings?"

Michelle

Definitely one that's close. I mean the scale of the galaxy is just so enormous that the vast majority of exoplanets that exists in this galaxy, I think, are too far, at least for the next hundreds, maybe thousands of years. Going back to the planet that I mentioned before, the one around Proxima Centauri, that one is only 4.2 light years away, and that has the closest possible exoplanet. So of course, we won't know what the surface of that planet will be like, will it be really dangerous for humans or what kind of precautions need to be taken, but I'm sure they'll put those precautions together before we think of any manned mission.

Kaylee

Or it'll be like adventure tourism.

Michelle

Yeah. Well, the Kepler team, and NASA have actually put together exoplanet tourist posters. Like I actually have them on the wall like "Kepler 186 F, where the grass is always redder on the other side", or "Where your shadow always has company because there's multiple suns on this planet". It's a really nice idea.

Michael

I mean, that would really be the ultimate to have that Luke Skywalker experience to watch a double sunset. I mean, I would pay as much money as I have to have that experience.

Kaylee

Okay, and we have one other question from Adam, who would like to know what forces influence the course of rogue planets? So maybe first, what's a rogue planet? And then what are the forces that influence rogue planets?

Michelle

So, a rogue planet is a planetary mass object, different people debate whether it's actually a planet or not. It's a planetary mass object that doesn't orbit any star. So, it might be free floating in the galaxy not gravitationally bound to any star like the planets are around our Sun. So how it would have come to be



that way? Well there's a lot of different ideas. For instance, there could have been a really close encounter with another star that stripped that planet from its own system, and just sent it totally tumbling through the galaxy.

Kaylee

That's really interesting.

Michael

Do we have any idea how many rogue planets there may be out there? Like we haven't discovered any, have we?

Michelle

Yeah, there have been some discoveries of rogue planets. You wouldn't be able to use the transit method to find one, but there's other methods mainly the direct imaging method. I'm not sure if that one has discovered any rogue planets, but theoretically it could, but microlensing has found some rogue planets.

Kaylee

What is microlensing?

Michelle

Okay, microlensing draws on Einstein's theory of general relativity, it's one of the more difficult ones to wrap my head around. Okay, I'll give it a shot. Imagine we're observing from the Earth, and there's a star that's really far in the background, and there's a star that's in between right along our line of sight. So, we've got the three objects that are in a line, if they're perfectly aligned, the light from the star that's in the background will be bent around the star that's in the middle. What we'll see is a magnification of light coming from that background star, like it'll look brighter than it actually is supposed to be. This only happens when the objects are perfectly aligned, and it's just due to the planets mass bending space time around it due to Einstein's general theory of relativity. So, then we add a planet to the mix, if there's a planet that's orbiting around that middle star, it will also contribute mass to the lensing effect, and you'll see another slight magnification of that lens star that's due to the planet, but without a planet there'll be kind of a big spike in brightness as that background star is perfectly aligned. If there's a planet it will be the same spike in brightness, but a slightly smaller spike of brightness somewhere along that main spike. That way you can say that you found some other mass that's causing this lensing effect.

Kaylee

Science bless you space nerds. That's incredible.

Michael

Speaking of nerds. Let's find out what everyone's nerding about. So, this week, we're actually going to be starting with some audience nerd outs, which you can as well if you want to tell us what you've been nerding out about, because I don't know about you Kaylee, but I've been really missing the in-person Fox Cabaret experience meeting new people, learning what they're nerding about.



Kaylee

The alcohol.

Michael

The alcohol definitely. So yeah, so please tell us what you've been nerding out about, and we've got a couple submissions already. First, Russ has been nerding about psychedelics, and their therapeutic uses. Kaylee, how's your psychedelic use this pandemic?

Kaylee

Not nearly enough, but this is an interesting area, there's quite a bit of work that's been going on, especially around micro-dosing of psychedelic mushrooms for things like anxiety, and I'm actually really interested to see what those studies will find.

Michael

Yeah, I've been really curious, because I think my Mom would benefit from maybe some micro-dosing of just like a little bit of weed, just like she's always been a very high stress kind of person. She's got some health issues. I've always kind of thought that she would benefit from it, and I mentioned it once and she was like, "Oh, absolutely not". She's very conservative in that way. So, I wonder, you know, it will take a while for that generation to catch on to it.

Kaylee

Well, you know what everybody else would also benefit from is a counselor or a therapist. We have another nerd out from Mily who's been nerding out about counseling in space. I thought this was really interesting, you know, being able to actually counsel people on space missions, especially because it seems like we don't seem to value mental health much on Earth, but we are recognizing that it's important in space. So it would be great to see if we could bring a little of that energy back down to Earth.

Michael

Michelle, would you ever go on one of those analog Mars missions, and really delve into if you've got the goods to go to deep space missions.

Michelle

I don't know. I like my life as it is, to really isolate myself, and I mean that's why counselors are necessary, because I'm sure that it plays something on your mind, either being isolated by yourself, or even just isolated with the same people in a tiny little capsule. That doesn't sound very fun to me.

Michael

I could certainly use some Deanna Troi in my life, that's for sure.

Kaylee

Oh my gosh, yes.

Michael

Yeah. Let's go to you, Michelle. What have you been nerding out about?



Michelle

I'm really excited about the Perseverance launch that happened last week. So, Perseverance is one of the Mars rovers, and it's currently on its way to Mars, but the really cool thing about this one is it's going to try to find signs of life on Mars. It'll be taking back some soil samples, rock samples, things like that, and I don't know if it will find any signs of ancient life, but just the fact that it's looking for it is really exciting. I know some people feel that the best place to actually find the next form of life that's not on our own Earth is in our own solar system.

Kaylee

So, once they've brought that soil back, will somebody be getting Matt Damon to go and plant some potatoes in it?

Michelle

Well, they'll have to be really careful about contamination, because there have been signs of life found in outer space, but it just turned out to be that someone didn't scrub the machine well enough. You've got to be careful of that, but I'm sure that they're doing all they can to make sure that doesn't happen.

Kaylee

Michael, were you also nerding out about the recent launch?

Michael

Absolutely. I did watch both of those launches. Before and after I was watching my next new favorite show. Now, last nerd out, I did talk about Devs, which is my newest new favorite show, but Dark, which just wrapped up its third season is also right up there. "Neither never, nor ever. Goodbye" is how the show starts. I find this little song, which was not actually written for the show, they actually took the song and used it for the theme song, and Dark is about time travel. It's about time paradox. It's about the nature of time itself. I was thinking as a science communicator, we are looking for new tools to communicate, and art and poetry I find can be really useful to explain really complicated subject matters and the show does have a little bit of science, it does go off on some crazy tangents. But I think about even just sort of like those words, "neither never, nor ever, goodbye", and how you could interpret that in so many different ways, but you don't really need to. The purpose of it is just to kind of get you set up to understand what the show is about, which is the very nature of time itself. I think there's a lot of lessons from a science communicator to use art, and maybe bring back some poetry into our craft. What about you, Kaylee? What have you been nerding out about?

Kaylee

Well Michael, you'll be so excited. I've actually been nerding out about Star Trek. So, for anyone who's listening, they know that Michael has been watching my favorite TV show Buffy the Vampire Slayer, and I have been watching Michael's favorite TV show which is Star Trek: The Next Generation, and in part it's so that we can understand the language that we each use, and you know I've started really enjoying it. I'm somewhere in Season 4, and as you said Michelle, there's a lot of philosophy in this show that I hadn't anticipated. I watched an episode the other day about this Altarian encephalitis virus, and it was super interesting. I was like, could a virus like that actually exist? So, there's been this one part of it that it's been really fun, but on a personal nerd-out, my Uncle Jerry and I were really, really close, and he passed



away about 10 years ago. So, Star Trek was his favorite show, and it's something that I never really understood why he loved that show so much, and now that I'm watching it, I understand. Some of the conversations that we've had in the past are starting to make a little more sense to me, and it's funny, like 10 years later. I'm starting to get some of his jokes, and so I've actually found it deeply personal, and also very entertaining. So, it's been a really lovely experience.

Michael

Well, Michelle, thank you so much for joining us on Nerdin' About. As you make your move to MIT, are you doing social media stuff? How can people learn more about your new discoveries, your new exoplanets? Which I'm sure you're going to discover.

Michelle

I don't have a Twitter account. So, people wouldn't be able to contact me through there, but anyone can send me an email, and you're welcome to share my email if anyone inquires. There have been people in the past who've talked to me over email just after a talk that I've given, or a podcast that I've done. I'm always really interested to talk to people about what I do, and how they can get involved with planet hunting. I mean, one of the things that I did for planet hunting is use a lot of code, but that might not necessarily be the way that certain people like to look for planets, there's a lot of other options. There's Planet Hunters, for instance, where you just need to go on to your internet browser, and look at pictures of these measurements of the brightness of stars, and you don't need any coding experience. So really welcoming anyone to ask questions.

Michael

Awesome. That sounds amazing. Yeah, if anyone out there wants to get into some citizen science, which I'm always a big advocate for, and join Michelle in being a discoverer of some brand-new planets.

Kaylee

I'm 100% signing up. I want to discover some planets, and name them after probably rats. Thank you everybody for listening and tuning in. If you would like to hear more from us, you can follow us @NerdNiteYVR on Twitter, Instagram, and Facebook. We'll be back in a couple weeks, but until next time, live long and prosper.

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