With Star Knowledge

Maria Hupfield and Jason Lujan in conversation with Dr. Hilding Neilson

Toronto Beaches, 44:13

Jason: Alright Hilding so where would you like us to look, or what do you want to do?

Hilding: Uh, I probably should have thought of that, shouldn't I? I don't know. I think-

Jason: I mean, we could put ourselves I guess here, looking at it. So, we can look this way.

Hilding: We could start, I guess we should start with the moon. I guess probably… how do we want to think about this? Do you want to come in from the astronomer's perspective, or from other perspectives, or..?

Jason: What's the Ojibwe word for the moon? Maria?

Maria: Oh, *Neebahgeezis* or *Nokomis*, like grandmother moon.

Jason: And where you're from, do you know what the word is?

Hilding: No, we actually use different words depending on the time of year.

Jason: Oh yeah, like what?

Maria: Oh?

Hilding: I could, the translation right now is fish spawning time, then, around Christmas is what we call chief moon, then like ice breaking and snow blindness, and basically, it's like a calendar.

Maria: Right, that's very similar because of how we would think about the months here. So another kind of seasonal. What about you Jason?

Jason: I actually don't know that word. I was just thinking about it. As soon as I asked the question, I started to regret it because I knew it would circle around.

Hilding: I think, if I actually looked it up, I would probably find that there is a normid word for the moon anytime, but I don't know it. I don't speak my language unfortunately.

Jason: But it's interesting to think about that it's all contextual the entire time.

Hilding: Yeah

Jason: Cool. Alright

Hilding: But I always think about the moon and how it's framed as 'grandmother moon', most cultures and nations as grandmother, sometimes grandfather, that sort of familiarity and relationship, and that with the sun being the partner. How it's a nurturing connection. As opposed to moon, which just sounds like a cow that fell over.

Maria/Jason: *laughs*

Maria: Yeah, where does that word come from?

Jason: I don't know

Maria: Lots of 'oooo'

Jason: I don't know Latin, but what do you find is the most interesting fact about the moon, or what do you find…?

Hilding: Well

[02:30]

Jason: If you were going to do a dating profile for the moon?

Maria: *laughs*

Hilding: Hello, people, I'm the moon. I'm slowly turning you around slower and slower as I go away and away, so catch me while you can because I'll be gone in a few billion years.

Maria: What do you mean by that?

Hilding: Well, we have tides, and tides are caused by the moon, right?

Jason: Yeah.

Hilding: So those tides are deforming the Earth and it's causing friction because the Earth doesn't like it, and that takes energy away from the Earth-moon system, so when we have the tides, that slows down the Earth's rotation, the moon gets further away at the same time, so our day gets longer and the moon gets smaller.

Jason: So, is its orbit kind of degrading so it'll eventually spin off?

Hilding: Eventually, in like billions of years, in a long time from now yeah.

Jason: When everything ends. Right.

Hilding: Yeah, it's a bit of a race, I mean, the sun will probably engulf us before that happens.

Jason: Ok. But mathematically, it's been calculated that the sun, the moon is leaning slowly.

Hilding: Yeah, you can actually calculate how much longer the day gets. Something like, a millisecond a millenia, or something like that. The other point is the earth and moon are the only places we can have a total solar eclipse in our solar system. So anywhere else when the moon passes in front of the sun, the sun is too small so it just blocks it out completely, as opposed to getting that corona, or the sun is too big, and you can't see it. So, we're the only place where we actually, in our solar system, have a total solar eclipse. Which I think is actually pretty cool, too. It's a weird phenomenon how the moon and the sun are the same size here.

[04:20]

Jason: Visually

Hilding: Visually, yeah.

Maria: That's a good point, yeah. So, we really are seeing that balance and symmetry when you talk about the sun and the moon on earth, or from earth.

Jason: So, we're looking at the moon Hilding, and it looks like the moon is centering, caught between two bodies up there, right.

Hilding: Yup.

Jason: What do you, what do you think those, I mean there's a plane at the bottom, but what are those two? Those are the two most visible, so.

Hilding: So I think, and I'm never very good at this, but the one on the left I believe is Jupiter, and the one on the upper right is Saturn.

Maria: Right, so the planets are really bright.

Hilding: Yeah, especially Jupiter and Mars, but we can't see Mars right now because it's on the other side of the Earth from us, facing, so we would see it during the day but not during the night. And Venus is even brighter, but we only see Venus in the morning, sunrise, or the evening.

Maria: Oh.

Jason: This is actually the first time, anyone live, has ever identified planets that I'm looking at in real time.

Hilding: I didn't, I used my watch app.

Maria: Laughs.

Jason: But you're here, you're like "oh, this is this planet". Usually, I'm used to everything being interpreted through a screen.

Hilding: Ah yes. That's too bad, because a couple of weeks ago we did the planet viewing party where we actually had great observations of Jupiter, and we're screening them across Canada.

Jason: Wow.

Hilding: You can see the bands going across it, we couldn't see the Great Red Spot because it was facing away at the time, but you could see the bands and you could see some of the moons of Jupiter, because they were overexposing it.

Jason: What is your relationship with the solar system and the planets professionally?

Hilding: Very little.

Jason: Okay

Hilding: I mostly work on other stars.

Jason: Oh, okay.

[06:18]

Hilding: But I think, in terms of our solar system, some of the things I'm interested in as it relates to other stars, I look at exoplanets that orbit other stars, so we sort of only understand them from the perspective of our own solar system, so we will see planets that end up looking like Jupiter, but they're really close to their host star, like much closer than Mercury is, and we don't understand, but we basically think it's like Jupiter. So, my relationship is a little bit off from there.

Jason: Okay

Hilding: In Canada, there are very few planetary astronomers who work on stuff in our solar system.

Jason: Oh yeah?

Maria: Oh, that's interesting.

Jason: So, you're stars then?

Hilding: For the most part.

Jason: So, one of the things, okay so, Maria and I are very interested in objects that are mirrored or intersected or twins, those kinds of things, so I know there's binary stars. Can you tell me something, like no dating app thing, what is of interest about binary stars, because I'm finding it hard to comprehend those kinds of bodies like that.

Hilding: Well-

Jason: Or that kind of energy.

[07:32]

Hilding: Binaries go around each other in the same way Earth goes around the sun. It's just gravity. But yeah, they have to almost entirely form from a cloud. So, you have like a dust cloud or a gas cloud, and when the stars form, the cloud collapses, and when it collapses it spins faster. Think of it like a figure skater, right, when a figure skater put their arms out they spin slowly, when they put their arms in they spin faster. And when it comes together, we think that it would form one star, but there's some instability, or some weird dynamic, sometimes you might get like a barbell, and you form two stars, and you come together. And for stars like our sun, about half of them have companies and binaries. And this is really important for us because one of the hardest things to do with understanding stars is weighing them, we don't know how, when we look at a star, like those two up top there, or right over our heads, I can't look at them and tell you how massive they are, whether they're like our sun, whether it's half, whether it's ten times or a hundred times the mass of our sun, but with binaries, we can do that, because it's force of gravity, right? They're spinning around each other, we measure them, we measure them using, when one passes in front of the other, so you see two stars here are very bright, one in front of the other, you block light, then you block light and we can measure that way. Or you can break down light into parts, into a spectrum. Think of it like one of those little prisms, in your home window, perhaps, and you have the rainbows… same idea, just way finer. So, you see little lines in that rainbow, and those lines are molecules and atoms that represent the composition and properties of the star. But when the stars are moving relative to each other, those lines shift back and forth. The same way, you know, you have a train coming, it makes a sound, the pitch changes as it gets closer and passes you by. The exact same physics. And we can use that to measure how heavy they are. And really we need that information because basically everything we understand about stars comes from actually weighing them. And so binaries are really important for that. And right now, we're seeing some really big results of this because there's an observatory called LIGO: Laser Interferometer Gravitational Oscillations.

[10:03]

Maria: *laughs*

Hilding: Astronomers and acronyms are the worst part of my field, and what this does is search for gravitational waves. And these are things, in the theory of relativity, if you have two objects orbiting each other, and the orbit's changing, they're bending space, because gravity is about bending space, and so when they're going around, it's like stirring a pot, you generate waves that go out into space. So, when the waves hit you, your body distorts, but that distortion is way less than the radius of an atom. And you know, my friend tells me, if you do this long enough, you generate gravitational waves. You'll never notice them, but you do it. So, we're detecting these gravitational waves, and they're coming from the merges of two black holes. And these black holes are born from these binary— from the most massive of binary stars. And so binary stars are incredibly important for understanding the properties of stars, black holes, and then we take and apply them to other galaxies, and that helps us go do things like cosmology. So, these binary stars really anchor a lot of our understanding of the universe. Thanks to that symmetry.

[11:11]

Jason: And we just talked about how the orbit of the moon and the Earth is, I don't want to use the word degrading, but it's changing over time so eventually they will not, they will separate. What's the condition for the binary stars, do they eventually over time, are they calculated to be combined— will they get closer, or will they split apart even further?

Hilding: So, the reason the moon and the earth are separated are because the tides cause friction. Because the earth is spinning at one rate and the moon orbits at another rate, what it's trying to do is it's trying to sync up. So, the spin of the Earth will not, orbit the moon. And stars do the exact same thing. There are tides on stars. And so, you can do that same distortion and they will synchronize. But there are also a lot of stars that appear to be two stars that have merged at some point, so that does happen, usually from different physics, usually the tidal physics reach some equilibrium eventually. But it's the exact same physics— I have a student who's working on this right now for a type a star and understanding how tides and those interactions help the stars evolve.

Maria: Wow.

Jason: Stars have tides, that's really amazing.

Maria: Stars have tides, yeah.

Jason: That's a great visuality to try to come up with.

Hilding: Yeah, well, from my perspective, if you think about it, so if you have a star that's going around, and going around this star, and this star's spinning at some rate, that's slower, or faster, you'll see like a bright spot either behind the orbit or ahead of the orbit. And that's basically due to a tidal bulge. We see them sometimes with the most massive stars, but it's hard to infer.

Maria: Wow. So yeah it sounds like you're talking… it's interesting thinking about the stars and planets as being about relationships in that way, right, relationship to each other.

[13:06]

Hilding: Yeah, I think everything in the universe, on a massive scale, is related to stars and physics. So, when the universe was born, there was hydrogen, helium, and a tiny bit of lithium. Everything else came from stars. Our oxygen, our iron, our copper, our gold, our silver, all came from stars and their interactions, whether it's in the core of the stars where we use nuclear fusion to create energy, or when stars explode and supernovae, or when stars called neutron stars, which are basically dying neutrons in a bundle, merge together and then they explode and they create all kinds of things as well. So, you know, everything that allows us to exist was basically born from a star at one point. And then there's the relationship and dynamics, we can't have the Earth and our solar system if we didn't have the sun. The idea is that when the sun formed, it was a gas cloud, collapsing, and when it collapses it spins faster, and thinking pizza dough, throwing it in the air, stretches out into a disk.

Maria: Yeah.

Hilding: And that allowed the planets to form. At least that's what we think. We actually don't fully understand how planets form. And so, we have that relationship, there, so everything that is about us comes from the stars. And same thing, it's like from the Cree, Mi'kmaq, and Anishnaabe traditions, that we come from the stars, this is one element of that, that we literally come from the stars.

Maria: Things are lining up. It's all matching up there. Wow.

Jason: I heard that all gold comes from stars. I wasn't aware that just about everything else does.

[14:56]

Maria: Yeah, how that worked, right? Yeah.

Jason: And our elements are made up of stars as well.

Maria: Also, hearing you talk about it, you have really good visuals as well to help me understand, and I am so aware of that distance between something that is beyond us and so far away, and that you're studying it from, at such a distance, and how you can also visualize that, so I'm thinking about how you understand distance, the space, all that other stuff around measuring all of that, the physics, and it's that information… are you going between a telescope and also a lot of information that is, I guess, used to be writing but now is on computer. How do you process it?

Hilding: Yeah, I spend way too much time in front of computers. I'm a giant nerd. And a lot of it is programming. Most of how we understand stellar physics is with giant computer programs we run, and these programs do things like fluid dynamics, nuclear reactions, magnetic fields, and we evolve them over time, and that's basically how we understand this, it started off pen and paper, and we would call people who did these computers, and we build up all these programs and then we test it with observations. Because really until only a few years ago, everything about astronomy came from light and photons. And it's sort of like taking a painting, sitting here and observing it in Hamilton through a telescope, and trying to figure out how the painter, what composition the painter used, or the paint, how dense was the paint, what was the canvas made out of…

Maria: That's ridiculous!

Hilding: And that's really what we're trying to do.

Maria: That's a strong telescope.

[17:00]

Hilding: And so, we're trying to infer this in that way from the light. In recent years, we have the gravitational wave oscillations, and if you go to Sudbury, we have neutrinos. Neutrinos are really cool too, because if you hold your hand out… that's like a trillion neutrinos that went through my hand. Now that's a stupid number that means nothing, but that's what they do. These really subatomic particles that are created in nuclear reactions. So, in the sun, nuclear fusion occurs when we take one hydrogen atom and one hydrogen atom and bash them together and you create a deuterium, which is a special kind of hydrogen. And you keep going and you keep building it up. But neutrinos are these little subatomic particles that are the byproduct. And they don't interact with matter almost entirely. So, they'll just zip from the sun and get here very quickly, whereas light takes a hundred thousand years to get from the core of the sun to the surface. It takes fourteen minutes to get to us. But neutrinos disappear in minutes and they go through everything. And so, in Sudbury, in the mines, they basically took a giant pot of water, a special kind of water, called heavy water, which is a different kind of hydrogen put together, and they buried it in the water, and they surrounded it by these, kind of, photoreceptors, so the neutrinos would hit the water and create this reaction – might create this reaction – and it would shine a little light. And this was done in the last twenty years and we were able to essentially detect the sun, which is the biggest neutrino source nearby, and that confirmed a lot of our ideas about the sun, but there's evidence that we actually saw a supernova in a Large Magellanic cloud, and this is a galaxy that, I am trying to convert it into light years now, is about seventy five thousand light years away. And if you go to the southern hemisphere, it's like the big galaxy in the southern hemisphere. It's so far away, like you know, it's just another galaxy, and we're seeing these particles reach us from there, most likely, which kind of blows my mind.

Jason: You don't know how long it took?

Hilding: Uh, well, it depends, the speed of light times the distance.

Jason: But for neutrinos?

Hilding: Neutrinos travel at the speed of the light.

Jason: Oh, they do? I thought they were travelling faster.

[19:18]

Hidling: No, the reason the time difference is different is because in the sun, photons basically hit everything and bounce around, so it's like pinball, the sun's a giant pinball machine for photons, but neutrinos, they don't bother, they just get to zip in a straight line. So that's why neutrinos take minutes, whereas, from the center of the sun, whereas it takes a hundred thousand years to get from the center of the sun to the surface for photons, because photons interact with everything. Hence, which is why I get to see you.

Maria: You're changing how I'm seeing everything now. It's so much.

Jason: That's an amazing... that's really, describing the mechanics of how things work is actually really incredible. Yeah. Is there anything that you wanted to talk about, we've kind of talked about a bunch of things that have been really amazing.

Maria: I have a ques—

Jason: I think the mechanics of the universe are just awesome, but what's your question?

[20:18]

Maria: I know that's great. The speed of light— yes I do. Well, I mean, I know I've already asked you this before. It's just because we're, here we are, at the beaches in Toronto, and I know I asked you before about where a good place is to see the stars in Toronto, and the answer was kind of like, outside of Toronto. Ha,ha.

Hilding: Yeah, there's way too much light here. I think the island would be pretty good. This is surprisingly, very well… just the horizon's a bit hazy tonight. And then I think you really have to go to High Park or north of the city, really, to do anything real you have to go north of the city.

Maria: Right. Just because of the light pollution.

Hilding: Yeah. And that's kind of… and, you know, light pollution is just one of the horrible things too, it's also… it's a weird thing to talk about this way, like light pollution.

Maria: *laughs*

Hilding: It's very much a form of colonization too, right. Because, you know, I don't know what stories you know from your group, your family, or your family, or my— like I don't know very much from mine, but they're a part of where we're from, right? What constellations I see in Newfoundland are different from the constellations I would see in Texas, or in the Muskokas, or anywhere else. And light pollution is a way of disconnecting us from that. And I think that's, in the same way, colonization has historically tried to disconnect Indigenous peoples from the land and from where we're from, and I think light pollution is just a byproduct that's continuing that tradition. And this is one of the worst parts of it in Toronto is that, how do you get to be related to the city and where we're at, if you can't see anything?

[22:10]

Maria: Right. If you don’t look up.

Hilding: Or-

Maria: And when you look up if you can’t see much.

Hilding: It’s just kind of grey. You know, so you see a few stars but I can’t pick out the consolations. If I wait long enough, I’ll probably see more people who are on CBC than I will see stars in the sky. It’s, you know?

Jason: Yeah. You lose your relationship to place, and people often think of place as the earth right?

Maria: Yeah

Jason: There’s- it’s a 360 degrees concept place. So- it’s true. That’s a really nice observation.

Maria: And also- when you mentioned depending on where you are in the world you look at the sky the sky is not going to be the same.

Hilding: Yeah, like, even the moon, like, you see the moon there are three dark spots there, like and that’s- growing up, you know, that would be the man in the moon.

Maria: Yeah, yeah the face. (laughs)

Hilding: If you’re in the southern hemisphere, if you’re in Australia, you got to flip it over. So, if you want to see what it looks like in Australia you got to do a handstand.

Maria: Oh

[23:13]

Hilding: So, it’s a whole different story now.

Maria: Right.

Hilding: And- so even the biggest object in the sky is a different perspective.

Maria: That’s true. Or if you’re seeing a rabbit up there.

Jason: That’s one more story involves a rabbit.

Maria: Is it even a rabbit. Rabbit on the moon. Yeah.

Jason: Actually, and we also have a story about a spider. There's a spider on the moon, a rabbit on the moon, and then the, uh, coward Aztec warrior. There's a lot, there's a lot on that moon.

Hilding: It's a busy moon.

Maria: (laughs) Yeah. Wow. When we first sat down before we turned on our mics Hilding you were sharing a little bit about the sky where you're from, where you grew up. I wonder if you could describe that or tell us a bit about- or even what- it seems so specific, what you're doing, the work that you're doing, your research. I'm wondering how much of that place where you're from might have shaped or informed that choice.

[24:21]

Hilding: Yeah. It's so weird. It's so, I was only in Newfoundland a couple weeks ago. It's been so long since I lived there so I really paid attention. But you can see the Milky Way, you can see the, you know, the Spirit Road or Spirit River, you can see the constellations, and it's… you're not alone. There are stars everywhere, you're, you're not, the stars aren't alone, and you're not alone, and everything's there in front of you. And from the horizon up, yeah you can see changes even, changes in the between plane – the horizon line, from the horizon as the stars rise because the light goes through different amounts of our atmosphere. But there's just something I can't describe about it cause it's just, so much, in that, in that, picture from where I'm from, I find, that stands out, like the big dipper and the little dipper are right on the front of the stage and you can't not see them, you know. So, it's very hard to describe in that way, but the irony is I didn't get into astronomy because of that.

[25:30]

Maria: Right

Hilding: I got into astronomy because I got into a course, or, because I couldn't get into the course I wanted to get into - Engineering. You know, cause Engineers make more money. And then I got into the Astronomy course and fell in love with it. And, now I don't make as much money. But that's kind of where it went.

Jason: You're talking to artists about this right?

Maria: (laughs)

Hilding: Sorry, yeah that's true. It's all relativity. It's relativity.

Maria: Oh, our loves.

Jason: What a flex!

Maria: (laughs)

Hilding: I take that whole thing back.

Jason: It's okay. I have a question, as a professional when you look at the sky do you just see, like, digits, or you know? What is your visualization of the sky now after doing this professionally? This doesn't have to be part of the interview.

Hilding: Oh no it's- it's not, it's definitely not numbers.

Jason: It's not the matrix?

[26:26]

Hilding: No, it's not the matrix. Nothing like that. It's, I know less than I think I ever did, every time I know less. Partly that's cause I'm kind of ignorant, ignorant of where things are in the sky. Like, I, if we picked a star name, I could tell you, probably might be able to tell you about the star- I have no idea where it is. I might have some idea from the constellation, where the constellation is roughly in the sky, but I feel like I know less now than I ever did. And, but at the same time it's, in that feeling less is also, you're seeing more of the mysteries. At least from the, you know, from the Western perspective is, how far away is it? What's it made of? Are there planets around that star? Are there, is there life on the planets around that star? Is the life on those planets around that star staring at us and wondering what's wrong with us? Which is probably how most people would look at us from afar. You know? Those are the big questions- what's going on. Or way beyond those stars, what was the beginning, what was the beginning of our universe like. From the first three minutes where the temperature was millions of degrees, and, and so, (light flashing), sorry that's really distracting.

Jason: It's, it's almost intentional.

Hilding: Yeah. It gives you really, it also gives nice creepy shadows.

Maria: (laughs)

[27:47]

Hilding: I feel like we're entering a horror movie. But you know, also cosmology, we're looking at the beginning of the universe through our telescopes if we can stare far enough. And with great observation, big telescopes and or radio telescopes we could look towards the beginning of the universe. Temperatures are starting at thousands of degrees, in the first few minutes millions of degrees, and you go back to the first minute- hydrogen hasn't even formed yet because it's not, all the sub particles that make up hydrogen, it's too hot for them to bind. And so, it's like this big plasma soup. And just understanding all these mysteries. And then understanding why is our universe such the way it is that we can live in it. If the force, you know, we define physics, physical laws of the universe based on gravity, electromagnetism, and nuclear forces. If those things, those forces interacted with us slightly differently, we couldn't possibly exist. And yet we do.

Jason: We'd be a different form.

[28:45]

Hilding: We, no, we wouldn't even…

Jason: It would just be what it is.

Hilding: It would be what it is but might not be any form either.

Jason: Oh, that's true.

Maria: That's very specific.

Hilding: Cause the atoms might not even be able to bind.

Jason: Which way is the center of the universe?

Hilding: Uh, every direction is the cen-

Jason: If you had to point to it-

Hilding: Every direction is the center of the universe.

Jason: Oh, really?

Hilding: Cause, the, this is where, this is where light comes from, becomes the issue here-

Jason: That's actually a pretty cool fact.

Maria: Oh, that's amazing! That's so true!

Jason: Every direction- that's the name of our work. I think you just helped us coin something there

Hilding: Yeah

Jason: That's the title of our next show, maybe. "Every Direction is the Center of our Universe."

Hilding: As long as it comes with the residuals.

Jason: Once again, you're talking to artists.

Hilding: I didn't say they had to be big residuals. But the reason every direction is the center of the universe is, when we look out into the universe we're actually looking back in time, cause light takes time to travel to us. So, when we look thirteen and a half billion light years, we're seeing the beginning of it, so it's every direction.

Jason: Yeah, we had talked about that-

Maria: Woahhh

[29:38]

Jason: -if we were to travel six hundred billion light years from planet earth with the right kind of science and look back at it you would see the dinosaurs.

Hilding: Yeah, if you, if we could be hundreds of millions of light years young.

Jason: And that makes

Maria: Oh, yeah yeah

Jason: That makes, like, time here feel here seem, really, really, irrelevant in a weird kind of way.

Hilding: A little bit. It's kind of weird thinking about that because you know the universe is thirteen and a half billion years old, the sun and the earth are about four billion years old, the universe will probably live a trillion years, in some respects it makes us very, well, insignificant, but yet we get to experience it.

Jason: So how are you feeling about how things are going so far.

Hilding: This is fun.

Jason: Yeah, okay. We're not too basic for you?

Maria: (laughs)

Hilding: No this is good, you're asking good questions.

[30:35]

Jason: I actually found what you were talking about with binary stars was actually really fascinating, about how you are able to measure them based on, just their pull, and things like that, and I really liked the painting analogy, that was a really nice, uh, relatable way.

Maria: Yeah!

Jason: How you deconstruct the process of a painting just using-

Maria: Yeah, very good, uh, visuals, you can really-

Jason: But also I think that you've done, you've done a really good job of like maintaining like a narrative, so when this gets-

Hilding: Oh, thank you.

Jason: -eventually edited down, I think we can get rid of some of the, uh, non-sequiturs, and it'll still flow really well so- I guess- we're pretty, are we about ready to wrap?

Maria: Yeah, I'm just wondering if there's anything else?

Jason: Yeah.

Hilding: Mm, well, we've covered stars, we got cosmology, I guess really Aliens, is the last thing that-

Maria: Ooooh

Jason: I didn't know you actually wanted to be on the record for that kind of stuff.

Maria: (laughs) No, let's hear it from the expert!

Jason: But I was going ask, what is your take, as an expert, this is all, like, uh, ancestor simulation, what do you think, what are the odds?

[31:36]

Maria: Ancestor simulation?

Hilding: Are we all in the matrix?

Jason: Yeah, sort of.

Hilding: I think that's sort of like asking what our mirror selves would do-

Maria: Woahh

Hilding: And, and, it's one of those things we can't answer. And, if we were actually in the matrix, and the matrix was done right, we'll never know.

Maria: That's true.

Hilding: And, so-

Jason: Cause like, a lot of, I've read, I started, I started, getting really fascinated by that, oh, this is, because it seems so far-fetched but-

Maria: My mirror self!

Jason: -a lot of leading scientists are like, putting it, at, like, 50/50-

Hilding: Yeahh

Jason: -that this is all a simulation, of some type, you know?

Hilding: It's- it's kind of weird right? And part of, I think, the simulation idea is the fact that the universe is too perfect, so there's a weird kind of design feature people think about.

Jason: Yeah

Hilding: And also, I think people just think the simulation because, if we go forward in time, from our perspective, we'll reach a point to how logically with computers, and quantum computers, that perhaps we can design a simulation in the universe that does basically this. And therefore, then we have bits and bytes that are having this conversation. And eventually they'll reach a point where they'll create a simulation and have bits and bytes having this conversation.

Jason: Oh, that's how that- okay.

Maria: Right.

[32:37]

Hilding: And so, it's a little bit, under the expectation- and it's kind of arrogant in my mind- that, well, we're getting to the point where we're able to do this, so, somehow, there's probably some civilization, somewhere, that's more advanced, that's advanced enough that they could program us, and, we could have this conversation, and, so-

Jason: Yeah

Hilding: I don't really put it as 50/50, I put it as, it doesn't matter.

Jason: (laughs) Okay.

Maria: (laughs)

Hilding: It's, it is what it is.

Jason: That's true.

Hilding: We are what we are.

Maria: We noticed something that was happening as well in the past couple of years, where suddenly the U.S. and other countries were no longer denying UFO's, so- give us your take: UFO's.

Hilding: Okay. I just want to make sure that, that my face is blurred out.

(**Jason and Maria** laugh)

[33:33]

Hilding: So. UFOs are kind of funny cause we, we have this preconception that a UFO is a flying saucer, or a triangle or something. But, a UFO, historically, is just something we never identified in the sky.

Jason: Right.

Hilding: There's lots of that.

Jason: I think they're calling them UGS or something like that-

Hilding: Yeah, we're trying to, they're trying to change the terminology so that it sounds a little less "science-fictiony."

Jason: Right.

Hilding: And sometimes, you know, UFO's have been just Venus in the sky, sometimes it's been some weird cloud phenomenon-

Jason: Right

Hilding: You know, various things. And the goal is to try to figure out what it is. And, you know, 99% Ithink we could figure out as some sort of, either, mistake, or-

Jason: It's a banal explanation.

Hilding: A banal explanation. But then there's that one percent we still don't know. Now, that, I don't know if that means, its, that doesn't mean it's an alien flying around and, you know, streaking us or something.

Maria: (laughs) Marvin the Martian.

[34:31]

Hilding: Or, it's something natural, and- but we can't, you can't say that it isn't an alien-

Jason: Right

Hilding: -because we haven't proven it yet. It's just, very unlikely. And I think the main reason why I think it's very unlikely is because, you know it's, the nearest star with a planet that could probably have life on it is at least 4 light years away-

Jason: That's an exoplanet, right?

Hilding: Exoplanet, yep. And so, if you're going to build a ship and fly it to here, that's like, that's like a generational thing.

Jason: Yep.

Hilding: And then you're going to take a generational thing, fly here-

Maria: Right-

Hilding: -and then just zip around and, sort of, play hide and seek with us?

Jason: Right.

Hilding: It seems kind of weird- and silly in some respects. And then I also, I have to ask is, if you come here and spend 5 minutes, as an advanced civilization who can fly here, are you going to look at us and think, "We want to hang out with you," with our nuclear weapons, and pollution, and reality TV.

Jason: (laughing) right.

[35:29]

Hilding: And, you know, so- I kind of feel like, it's probably very unlikely that alien ships have visited the earth. It's very hard to do. But, we can't, you can't absolutely discount it.

Jason: Right.

Hilding: I just think it's the conclusion people want to jump to because it's much more interesting than precipitation, or some background Venus, or a reflection of light from something else.

Jason: Yeah. I've done a lot of reading where they, a lot of scientists, they're, they're not astrophysicists, they're just, they're usually, like, paleontologists, those kinds of science things. But they feel that our isolation is actually our biggest asset. Because when you look at the, when you look at the behavior, of, of humans, and what humans do to each other when, you know, when they meet people who are different, it doesn't bode well if someone else comes along.

Hilding: Yeah…

Jason: Right? For us, or maybe even for them, but-

[36:23]

Hilding: I always, I find that kind of, stigma, uh, that kind of, belief- and that's a common belief around, around a lot of scientists, like, you know, Steven Hawking was famous for sort of saying, "we don't want to mess with people, cause they're going to come here, and you know, take our stuff." And my thought on that is, why would they?

Jason: Why would they?

Maria: Right.

Hilding: There's a whole galaxy, if you could travel here, there's a lot of stars, with, probably does have life you can mess with there. But also, that's not all humans that did that. I mean- let's go back 500 years, we kind of all lived here, in, in Turtle Island, pretty copacetically. We were pretty content. And we had our kind of ways, and it worked out pretty well. The humans that took it were the, were probably the, what we would call, the Colonizers.

Jason: Right.

Hilding: Or the Settlers. And I think when we sort of talk about aliens, and that kind of, you know, invasion, kind of, narrative, from that perspective. And if I think, I think, personally if we were thinking more about, you know, alien civilizations perhaps from a more, Indigenous, you know, Anishinaabe, Salish, whatever perspective, would they do the same thing? In that, as we kind of impose that kind of Settler narrative towards aliens. What would the different narrative be? And I think actually, they would just avoid us because they would look down at us, say, "nuclear weapons, global warming, you kill each other for liquid that comes out of the ground," we're just-

[37:52]

Jason: We're unsalvageable.

Hilding: "We're just going to, you know, keep going-

Jason: Right.

Hilding: "and avoid you." Uh, and, I think, so I think really, we impose a lot of our narrative around aliens that, and this is very much science fiction, just comes from the same settler colonizer ideals that are historical.

Jason: Do you read a lot of science fiction?

Hilding: I try to. I enjoy it. But a lot of, this, where this came from, is actually a couple scholars who talk about as this as, basically like, in movies like *Independence Day*, is basically the modern version of *The Western*, whereas, and it's the same settler colonial narrative. And, and it's, a lot of the times a lot of it is. And even Star Trek, is a little bit, has a little bit of that at times.

Jason: Yeah, it's very problematic.

Hilding: Yeah.

Maria: Wow.

Jason: That's interesting.

Maria: Well, it makes me feel a little unsettled, (laughs), as a person, in the world.

Jason: There's nothing we can do, I mean, it's really, a lot of this comes down to, it's out of our hands, so, we, we just have to, live now.

[38:53]

Hilding: But the, I think the thing to take away from that is not that they're going to avoid us or they're not there, it's, they're somewhere out there-

Jason: Yeah

Hilding: -around the stars. And, you know, there-

Jason: The odds are, right? That there's-

Hilding: Yeah. We're not alone.

Maria: Yeah.

Hilding: And I think that's far more reassuring to me than if we were in a galaxy or universe alone.

Maria: Totally isolated, yeah. Well even Jason, I remember you talking about this like, you know, about death and this idea of becoming part of the universe and returning to the stars and that that was something that was very comforting for you.

Jason: Yeah, oblivion is something you find very comforting.

Maria: Yeah, and I also feel like, even to situate ourselves now, like here we are on the beach, there's sand, which has another kind of reference, to like, you know-

Jason: -The stars.

Maria: -The stars, literally, and then kind of sandwiched in between.

Hilding: Yeah- you know, count the pebbles of the sand, and count the stars.

[39:50]

Maria: Yeah. Cause on a really clear, clear night, depending on where you are, that's what it's like. Right? You look up, and I can remember looking up and seeing like, this incredible infinite dome of like,

Jason: But ultimately it would just be completely white, over time.

Hilding: No, that's-

Jason: No?

Maria: Oh?

Hilding: That's- that's actually a good question. Cause this was actually, this was a weird thing about cosmology, cause people used to think of science that the universe was infinite in all directions in both time and space.

Maria: Right

Hilding: And if there's nothing in the way, then the universe, the sky would always be white.

Jason: Yeah.

Hilding: But, because the universe is finite light hasn't had time to reach us, but also, between us and all the stars is gas, and dust, and materials blocking the light. So- when you see, like, the milky way and all those clouds, that's dust and gas and particles. And so that blocks a lot of the light too.

Maria: That makes sense.

Hilding: So we can have a dark night as opposed to basically always being blinded by the light. Like we are now, I guess.

[40:49]

Maria: Right, right. You're making me really aware of how the universe, so much of that is about space as well and being aware of how the planets are moving. Like, yeah. It's not a-

Jason: I like this, yeah

Maria: -we're so used to thinking of the sky as being like this flat map or, you know, like the mapping of the sky, or the, yeah.

Jason: That's true we're moving too. That's what we forget.

Hilding: Yep.

Maria: Yeah, everything's moving.

Jason: So it's going to be changing all, yeah, that's true.

Hilding: We go around the sun every year. And the sun goes around the center of our galaxy every 25/30 million years, and our galaxy is going toward the Andromeda galaxy, which in 5 billion years will merge.

Maria: Yeah, everything is in motion.

Hilding: And galaxies are drifting, and the universe is expanding so everything, other galaxies are pulling each other apart, or pulling apart from each other. So, you know, in a few trillion years, or something like that, we actually might not see other galaxies.

[41:49]

Jason: Are your- do your studies involve entropy?

Hilding: Sort of, sometimes. So, the idea of like, decreasing entropy over time?

Jason: Well- you're talking about the end of the universe, so yeah.

Hilding: Yeah, so the big freeze is one element. And there's, the end of the universe is kind of a weird, funny problem now. Because what we've learned is that the universe is expanding, so, the space between things is growing over time. So, you take a rubber band and stretch it, and so the universe is expanding in the exact same way. But what we're finding is that we used to think it was like a constant velocity, but now there's the acceleration, so the expansion is getting faster with time. And, what we, don't- that's a whole weird thing, that's, we call it dark energy. And we call it dark energy cause we're too lazy to describe something more meaningful. It's dark because we don't know. And-

[42:44]

Maria: Dark meaning unknown?

Hilding: In this case, yeah. And so, we call it dark energy, but what it means in the fate of the universe is we don't know. We could, we could have, like, heat death where, as the universe expands big enough and big enough as the universe gets colder and colder and colder and if things stop being able to produce energy, we would basically freeze at absolute zero. Or perhaps the universe is accelerating so fast that eventually it's just going to rip itself apart. Or dark energy will change and instead of accelerating things apart, it will pull things together, and we'll just snap back, (claps), and have a big crunch.

Jason: Right.

Hilding: So, there's the big rip, the big freeze, and the big crunch. Sounds like a nice day at the beach.

Jason and Maria: (laugh)

Hilding: And so, we have all these options, but we really don't know cause it's all extrapolating from one measurement of dark energy in time but, these are all these things that could happen. Of course, nothing might happen, we might just slow down and be cool for infinite time.

[43:43]

Maria: Right, that sounds like a tasty-

Jason: We won't be around for any of this anyway.

Maria: Oh, yeah.

Hilding: Speak for yourself.

Jason: We'll be, we'll be long gone… Oh really? I'll be long gone.

Hilding: If we're in a simulation we could find a way to break it and, and live.

Jason: But why?

Maria: Multiples. Wow.

Jason: Ok, I think we're good. Yeah. Do you feel good about this?

Hilding: I'm good if you're good.

Jason: Okay.

Maria: I'm good.