3 Takeaways Podcast Transcript

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Ep. 192: An Other-Worldly Talk About Other Worlds With The Chillest Astrophysicist Alive

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Lynn Thoman: Space is weird, and wonderful, and even stranger than we can imagine. Some amazing facts.

[Sound effect SFX]

Lynn Thoman: On Venus, it snows metal and rains acid.

[SFX]

Lynn Thoman: On Saturn and Jupiter, it rains diamonds.

[SFX]

Lynn Thoman: Saturn, in fact, is so light, it would float in water, in spite of all those diamonds.

[SFX]

Lynn Thoman: On Mars, if you stood at the equator, the temperature at your feet would be warm, but above your head, it would be freezing cold.

[SFX]

Lynn Thoman: If you're traveling in outer space, your face puffs up, and you grow about two inches taller due to gravity.

Only about 5% of the universe is made up of the kind of stuff you, me, the Earth, the stars, and galaxies are made of. Here's another unlikely fact.

In spite of the high likelihood of advanced extraterrestrial life existing somewhere out there, we haven't encountered it. Yet. Why is that? And what are the chances of making contact soon?

Hi everyone, I'm Lynn Thoman, and this is 3 Takeaways. On 3 Takeaways, I talk with some of the world's best thinkers, business leaders, writers, politicians, newsmakers, and scientists. Each episode ends with three key takeaways to help us understand the world, and maybe even ourselves, a little better.

My guest this week is Janna Levin. Janna's a professor of physics and astronomy at Barnard College at Columbia University. She's also the author of the wonderful books How the Universe Got Its Spots and Black Hole Survival Guide. Maybe even more impressive, there's a bar, a kind of speakeasy, in her office, and Janna has been called by Wired Magazine the "chillest astrophysicist alive." I'm excited to find out more from her about the infinite wonders of space.

LT: Janna Levin, thanks so much for joining 3 Takeaways today.

Janna Levin: Thanks for having me. It's going to be fun to talk.

LT: I'm excited. Have we found potentially habitable worlds and the ingredients for life elsewhere in the universe?

JL: Yeah, we have found candidates that look very well-suited as habitable planets, but you also have to understand habitability is so based on our experience. We're so working backwards. We're saying, oh, we are this very carbon-based life form, which really needs water in our very cellular makeup to survive. Therefore, we're looking for rocky planets with lots of carbon and water. That's not totally off. I mean, that is sensible. We know that carbon and water are special properties electromagnetically, and that's why there's so many ways that they can combine and so many ways for them to radiate life.

So it's sensible, but we're also really challenged when we're looking at other planets. I mean, they come in varieties that we can't, well, we can imagine, that we don't have any experience with. If you even think about the premise that their central stars that they're orbiting are so different from ours, it might not even shine a light that our eyes can see.

And what would that mean for photosynthesis and plant life and just so much that's so bound to the Earth's ecosystem would change. So I think the short answer is yes, we expect habitable life amongst the huge number of planets that we know are out there, billions of planets in our own galaxy, and yet it's going to be hard to recognize it even if we see it.

LT: Let's talk about the possibility of life elsewhere. Over 50 years ago, Nobel Laureate Enrico Fermi did some math using rough approximations of the vast numbers of planets and the odds of life developing on each planet. His back-of-the-envelope calculations suggested there should be lots of civilizations, and he famously asked the question, which has become known as the Fermi paradox, where is everybody? It took 3 billion years for us to go from single cells to complex life, which suggests that taking this step is hard and complex. There are essentially three possibilities for life elsewhere.

> #1 Life may be rare and short, and we have missed others by millions or billions of years.
>
> #2 There is no other life.
>
> #3 There is life, we just haven't encountered it yet.

What do you think?

JL: I think that it's a combination of #1 and #3. I find it impossible to believe that we're magically the only experiment in life when we look at our own galaxy, which is a collection of 300 billion stars, and we think that a large fraction of those have multiple planets. It might very well might be that there's more planets than there are stars in the universe. That's just our galaxy. If you look at hundreds of billions of galaxies just within our observable field of view, just stuff where the light makes it to us, it seems utterly improbable there isn't life.

However, Fermi was talking about civilizations. That is a much higher bar. As you said, to go from single-celled organisms to multicellularity took over three billion years, and it's not as though those three billion years were just kind of waffling. It's not as though it was very quick from one step to the other.

Something was holding it back, the process, the energetically favorable transition from single to multicellularity. It was not energetically favorable. It was really hard to do.

So I think every scientist that I know and speak to seriously, absolutely, is convinced there's microbial life out there somewhere, and that is really what we're searching for.

When we're doing the scientific exoplanetary searches, we are searching for biosignatures of microbial life forms. We're not looking for messages from civilizations. That program under the purview of SETI, the Search for Extraterrestrial Intelligence, is very different. They're looking for civilizations and intelligence, and the exoplanet searches are really just for microbes, largely. In the past hundred years, we've been sending signals to space and traveling into our very, very, very local environment.

Not really into space, but just boring into our backyard in the solar system. You know, our moon is like our backyard. And those signals that we've sent out into space have not gone more than a hundred light years. You know, however many years it's been since we started sending those intentional signals from a civilization to another possible civilization. A hundred light years around the Earth is a very small environment. And even if there's hundreds of planets, exoplanets, other solar systems, in that very small, little, tiny area around us, the likelihood that they also have a civilization that is manipulating metals and technology and has only done so in the past hundred years and hasn't killed themselves and hasn't wiped out their own societies, all of that seems very unlikely. Incredibly unlikely.

LT: What do you think about the possibilities of advanced life, advanced civilization, broadly, far from Earth?

JL: Broadly, far from Earth - I'm very optimistic that nature has tried many, many experiments. And one of those experiments will be very successful. And it might be very, very different from our experiment. So I am also extremely excited about the prospect that somewhere in the universe, civilization is unbelievably successful.

And it could be so vast, millions of years away, and we're seeing those galaxies as they were millions or even billions of years in the past before the civilization even emerged, when it was still the simple organisms differentiating in some kind of primordial goo.

And so it's not just a simple numbers game. It's the probability of it happening, successful civilizations, and their proximity to us so that we've had a chance to receive their signals, all of which travel slower than the speed of light.

LT: What are some facts about the universe that would blow people's minds?

JL: Well, you mentioned some really cool facts. You mentioned one that I think is really quite profound, that everything anyone has ever seen or ever will see in the universe, and by see I really mean detect through light, makes up less than 5% of what's out there. That by far, most of what makes up the kind of energy content budget of the universe is in a form of dark energy or dark matter. And they really` should be called invisible, because the dark matter, which is right now all around me, I cannot see it.

It is not dark. There's no darkness that you're looking through. It's invisible, and it's invisible because it does not interact with light.

Now, the exact nature of the dark matter and the dark energy is unknown to us, but we do know of examples of dark matter. They're just not prevalent enough to explain such a large abundance. There's got to be more dark matter than the dark matter we know of.

We know, for instance, that there are particles called neutrinos, and we see them, actually we detect them. We don't literally see them. We detect them through a very, very weak interaction that's not with light, and we get them raining down on us from the sun, like right now streaming through this very room, and because they don't interact electromagnetically, we can't see them with our eyes. They're not banging into the table. They're largely passing right through undisturbed, so they're really invisible, not dark.

I think that's quite amazing. It means in a very wild kind of fantasy extrapolation of that that there could be an entire invisible planet made up of this dark matter, and there could be invisible creatures, invisible to us. They could be visible to each other. They could have a whole map of all of the interactions that make the world the way it is for us, that make it possible for things to bind together and make bodies and to metabolize things through electrical systems and moving electrons around and all the same kinds of things, but it would be all particles that were dark to us, and we'd be dark to them.

That dark creature could be sitting right here, and I wouldn't see them, and they wouldn't see me, and we wouldn't even know we were both here. The only way that we interact seems to be through gravity, and that's how we deduce that dark matter is out there. We can see it bending space and time. We can see this massive deformation in space-time that's creating all of the usual stuff we expect of heavy galaxies and things like that, but it's totally invisible.

LT: And about how many planets do we think are out there, and about how many of them do we think might be similar to us?

JL: I don't want to argue about Pluto, but if we figure we have at least eight planets after Pluto was demoted, and then we've got a whole bunch of other rocky objects out there by

Pluto far out, even if we stay conservative and ignore all of those, we'd say, oh, we've got eight planets. That's a lot of planets for one star.

So in our galaxy, the Milky Way, with its 300 or so billion stars, if you figure, I think the modern estimate, it might have changed, but let's just say a quarter of those or a fifth of those have planets, it's probably more than that, so that's the lowest. And each one of those planets has eight more than there, again, are more planets than there are stars in our galaxy. So hundreds of billions of planets just in the Milky Way, and then when you look at all of these galaxies, when Hubble opened our point of view to see, wow, it's not just us, all of these billions of other galaxies, each one of them having billions of stars, it's a very big number.

I don't really have a good name for it. And it's a huge number. So let's see, hundreds of billions is like 10 to the 11th, so trillions times trillions. And that doesn't mean the whole universe, that's just the part we can see.

LT: It's so vast. It's hard to actually even imagine. How about black holes, Janna, can you tell us about them?

JL: The idea originally was just to fantasize, just imagine, pretend that you crushed all the mass of, say, the sun or a star to a point. Nobody asked, is it possible? Would nature allow you to do that? It doesn't matter. Just imagine. It's a thought experiment. It's for fun. And in the context of studying the space-time around it, they realized, oh, there would come a point where not even light could escape the curves in the space.

It would be like a waterfall of space-time pouring inward, and like a fish kind of swimming against Niagara Falls, there would come a point where it just couldn't make it anymore, and it would fall into this waterfall of space-time. And that's what we really mean by a black hole. We mean a region around possibly a very dense point where not even light can escape.

You would have to travel faster than the speed of light to make it away, and you cannot, and so it creates what we call an event horizon, a region that separates outside from inside forever. And the way that most people are familiar with and have heard of, is that if a star is very heavy at the end of its life cycle, when it runs out of thermonuclear fuel, it will begin to collapse under its own weight. And that collapse will become so catastrophic that it will not be able to resist the catastrophic collapse, and so eventually it gets so dense that not even light can escape. The event horizon forms, but the star itself can no more hover there than it can race outward at the speed of light.

It can't do that either, so it's forced to continue to fall as well, and the star is gone. And we see that there are probably, maybe 1% of the stars in our galaxy, will end up as black holes, and that's still a lot.

LT: So interesting. Is there just one universe?

JL: I think the answer is a pretty easy no. We usually mean by a universe that we can trace back everything that we can see back to a common high-energy moment, which we're calling a Big Bang, where everything in the universe was much closer together and everything was much hotter and higher energy and that's when the clock started.

That's when time began as far as we are able to measure our perspective on time. If you imagine this kind of like space-time ginger root, that our Big Bang was just a tiny patch of this ginger root that blew off and became our universe, and over here a different Big Bang happened, and it blew off and became its universe. I think it's pretty hard to believe that something like that isn't a better idea than saying, oh, Big Bang just happened once, and it's just us.

LT: So amazing. Janna, before I ask for the three takeaways you'd like to leave the audience with today, is there anything else you'd like to mention that you haven't already touched upon?

JL: I guess I would just like to reflect on how thinking about these very abstract things, people often ask me, what does this have to do with me? How does this improve life on Earth? I think it has a very profound consequence in terms of how we view ourselves, how we view our significance in the world. And I think also how we view others.

And I think if we have these moments remembering, you know, we're all on this little rock together in this incredibly remarkably vast universe, and we all share this in common. I think it can be quite transcendent. I think it's a way of really understanding as well where we are right now and who we are right now and what we should be doing.

LT: Janna, what are the three takeaways you'd like to leave the audience with today?

JL: First, black holes are nothing. They are a place as much as they are a thing. If not, they're more of a place than they are a thing.

That most of the universe is invisible to us and we to anything made up of that material, the dark energy and dark matter. That would be number two.

And I think the third takeaway is that life is probably not rare, but civilization maybe.

LT: Thank you, Janna. I have loved this conversation.

JL: Me too. And so fun to talk to you.

LT: Thanks so much. Janna Levin is the author of the wonderful book, Black Hole Survivor Guide. If you enjoyed today's episode, you can sign up for the 3 Takeaways newsletter at 3takeaways.com, where you can also listen to previous episodes.

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I'm Lynn Thoman, and thanks for listening.

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