Paul Thies: Talk about a record that literally flew off the charts. You can't get much more extreme than the Golden Record that NASA launched back in 1977 aboard the two Voyager deep space probes with 115 images, spoken greetings in 55 languages, [00:00:30] a host of animal and nature sounds, and musical selections from Bach to Chuck Berry. The Golden Record represented humanities yearning to make contact with life among the stars and to say hello. As the Voyager probes make their way further and further into space, it begs questions such as, is there anyone out there who might give the Golden Record a spin? And where's the record that's coming our way? Hello, I'm your host, Paul Thies. And on this episode of If/When I sat down with two experts [00:01:00] from the famed SETI Institute, whose passion is listening to the stars and seeking new life. Joining me today, are Dr. Nathalie Cabrol, Director of the Carl Sagan Center for the Study of Life in the Universe and Dr. Seth Shostak, Senior Astronomer.

I asked Nathalie and Seth to expound on topics such as if intelligent life is out there, why has it been so hard for us to find any evidence of it? And what can extreme environments on Earth teach us about the potential presence of life [00:01:30] on other planets? I also shared a number of questions submitted by our listener audience.

All right, well, Nathalie and Seth, thank you both so much for joining me. I've got to admit, I've long been a fan of the work of Carl Sagan and the SETI Institute. I know when we put this on the docket to do, as far as podcasts, we had a lot of our listeners. We're very interested in this topic, we got a lot of questions. I wasn't able to include [00:02:00] them all of course, but we do have some listener questions as well, and we'll get into that as well. But first of all, thank you both. I know how busy you are. Nathalie, I believe you just got a book put out and have been making the rounds, I think back from Europe. And Seth, I know you're perennially busy on TV and stuff. So again, thank you both very much.

Seth Shostak: A real pleasure, Paul.

Nathalie Cabrol: Yeah. You're welcome.

Paul Thies: Thank you. All right. Seth, I'm going to start with you and I've got what I'm [00:02:30] calling the unfair question, and it's namely, if intelligent life is out there, why has it been so hard for us to find any evidence of it?

Seth Shostak: You could come up with lots of responses to that, beginning with, maybe there aren't any aliens. It seems a little unlikely given the prevalence of planets and the fact that there are many, many worlds that could be similar enough to Earth to spawn intelligence eventually. I think that the answer that people in the SETI [00:03:00] field would offer you is that we simply haven't looked in enough places with enough sensitivity. If we were on the next planet over, outside our own solar system, in the Proxima Centauri system, then there is a plant there that's about the same size and average temperatures. If you were there with our SETI experiments, you would not be able to pick up the Earth. In general, you would not. So that gives you some idea, the limitations [00:03:30] of this kind of an experiment. It requires some fairly special behavior on the part of the aliens. And I think that's the answer to your question.

Paul Thies: And maybe our technology's just not there yet, or we haven't expanded our footprint galactically, as it were, to where we maybe can pick that up, I guess.

Seth Shostak: Yeah. Keep in mind, we're not broadcasting, we're just listening. It isn't that we're waiting for the aliens to notice us.

Paul Thies: I [00:04:00] got you. Now, are you using emerging technologies such as data science or artificial intelligence to aid you in the search?

Seth Shostak: Yeah. Certainly we are. Particularly over at the University of California, Berkeley, where they have already tried using artificial intelligence, really machine learning, to recognize when a signal is a candidate for being E.T. and when it's not. By the way, in the movies, [00:04:30] you get the impression that you only pick up a signal every couple of weeks, or maybe never, but that's not the case. The facts are that you pick up signals every minute you pick up several signals, right? So you have to sort through those and machine learning is a good way to sort through them. Humans really don't have the bandwidth, to use a local term, to do that.

Paul Thies: No, I can imagine. You're probably picking up all kinds of interstellar noises. I can imagine what all it is, but you have to comb through that. [00:05:00] And, oh, that was [crosstalk 00:05:02] there's nothing there.

Seth Shostak: The kind of signal we look for, which is say a narrow band signal. A signal that's at one particular frequency on the radio dial, those kinds of signals are not produced naturally so we don't have any problem with Quasars, Pulsars, hot or cold gas, all of which produce radio signals, yes. But they're not the kinds of signals we're looking for. So they really aren't part of the problem. The problem is [00:05:30] Homo sapiens, but Homo sapiens is always part of the problem.

Paul Thies: What kind of advances in technology, Seth, do you think will be needed to finally break through and discover life among the stars?

Seth Shostak: One never knows. You can't say, "Are we close to finding a signal or not?" I unfortunately bet everybody in an audience in Germany a couple of years ago that we would find a signal before about 2035. Right? [00:06:00] And I bet everybody a cup of coffee, so I'm probably going to be buying a lot of coffee because of that. But the reason is that, indeed the equipment does keep getting better. And in fact, if you grasp the improvement of sensitivity, or search space, or anything, any metric of the SETI effort with time, then you find it doubles roughly every two years, that's just Moore's Law for computers. That's not a coincidence because computers are essential [00:06:30] to what we do. And as the computers get faster, we can sift through the sky faster.

Paul Thies: Nathalie, one of the areas of expertise that you are in is looking at extreme environments. You can see videos and papers, Nathalie has traveled to some pretty extreme places here on Earth to see about the conditions that can support life. My first question for you Nathalie, is what can [00:07:00] extreme environments on Earth teach us about the potential presence of life on other planets?

Nathalie Cabrol: Well, this is an interesting question because we are still trying to figure out how life started on Earth here. A few decades ago, we started to look at very interesting places, like the bottom of the ocean or in other places like hydrothermal systems, and then we realized there is a range of microbes that survive in impossible places. And at the same [00:07:30] time planetary exploration was taking off literally, and so we discovered that some of this environment were very similar to what we're is seeing in those places, so especially Mars, or Europa, or Enceladus, et cetera. So by going to those places on Earth, first, we are learning a lot about our own planet and our origins, but we are also learning what kind of microbes could survive in those different environments in the solar system. And [00:08:00] even better than that, by studying them, we are also understanding how we should be exploring them. We are trying instruments and we are trying exploration strategies in those extreme environments. So this is what they are for, they are incredible test beds for a number of things.

Paul Thies: Let me ask you on that. If we were to find microbial life on another planet, what criteria would be needed to ascertain if there was any relation to the emergence of life [00:08:30] on Earth? How do we know they're not mutually exclusive?

Nathalie Cabrol: Yeah. Again, this is a wonderful question and so timely because right now astrobiology is coming up with a white paper, especially regarding that question on how can we announce the discovery of life. It's not an easy thing. Just because we don't know what life is, we don't have a consensus definition for life on Earth, believe it or not so it's hard to look for something we don't have a definition for. [00:09:00] I think it's like everything else and Seth probably can say the same thing for the SETI signal. You have to have a number of converging evidence and life has always to be the hypothesis of last resort, and this is how we work. We are going to say, "Okay, this thing seems to be reproducing. It seems to be metabolizing. It does the kind of things that we recognize as processes for life on Earth." Of course that is for life [00:09:30] as we know it.

What we are doing right now is to try to develop [inaudible 00:09:36] frameworks, a checklist of things that would match that. But as far as we know, at this point in time, there is not an unambiguous bio signature. And this is where we run into problems sometimes like with the Viking biological experiment. This one is easy enough because in '76, when [00:10:00] we had some evidence showing that it potentially there was life doing something into that experiment. We had no clue about the environment, the Martian environment, that was the first landed admission on Mars so we had no clue. When you have an equation with two unknowns, you better know at least one of them. So you can talk in an educated fashion about the other one.

And we knew very little about both of them so we saw and we realized that it is likely [00:10:30] that the environment created that signal that we saw with the Viking experiment. Then we had another Martian rocks, the Allan Hills meteorites and the difficulty of understanding what we are seeing are fossils or something else. And then more recently the Venus phosphine. So these are the kind of things that make you reflect on when will we be able to say that we recognize life? I always joke that unless there is a rabbit jumping in front [00:11:00] of a Rover on Mars it will be difficult at this point in time. But if you allow me, I'd like to comment a little bit on the question, you asked Seth, why E.T. is not responding.

There are a number of reason Seth mentioned, but there are also some event that are there again, because we don't know about the life process in the universe. I'm with Seth with that, there are too many planets all over the place for us to be alone. [00:11:30] It's statistically an absurdity to even state that's the case, but then you have to think about, and again, just for life as we know it, is life as we know it a generational process? Which means that the kind of life we know we could recognize, et cetera, has come to be just because the stars that preceded us just released recently, the type [00:12:00] of material that makes life as we know it.

And we know it's a little better place, there again, another good reason for a life to be abundant, but it may be that the type of life that we know of started at about the same times. So maybe there are lots of very young civilization. Maybe there are also all of them waking up to the possibility of communicating, and then we have to be synchronous in space and time. There might be many other reasons, right? But there is at least this one that [00:12:30] we can add to the list of hypothesis.

Paul Thies: Oh, it's interesting. One of the questions that had come through from the audience was basically positing that given how long it's projected the universe may last, or the lifespan of the universe, I'm not sure where this was coming from, but that we're in the early days of the potential lifespan of the universe. And so maybe we're just on the cutting edge of life, but that life [00:13:00] will happen and occur much longer in these crazy time spans way out. And we're just happen to be the only kids in the block right at the moment. I don't know, and I don't know how you even how you even figure-

Nathalie Cabrol: No, no. There is something about that hypothesis though. Again, we don't even know what life is, and there are some very, very strange hypothesis coming about from quantum physics these days and neuroscience, et cetera, so I'm not even going there. The staying universe as we know, the thing [00:13:30] I would say is that, if we are right about the universe expanding and galaxies producing less and less stars, then you are coming up with a problem. We might be at the time where it's a good time to be alive, just because the stars are producing the right stuff after that we might be running out of fuel. I don't know what you think Seth.

Seth Shostak: Life on this planet is based on really a handful of the elements. Carbon, nitrogen, hydrogen, oxygen, sulfur, a few [00:14:00] others are in there, but those are just the big ones. They make up probably 98% of the weight of all life on this planet, and many of those are made in stars. So at the time of the Big Bang, or shall we say a hundred million years after the Big Bang, yeah there was a lot of hydrogen and helium, but there wasn't very much carbon, for example.

However, and this is just the field of astronomy, we know that stars had already begun to seed space with the elements of life very, very [00:14:30] quickly, maybe within a billion years after the Big Bang. In other words, by far the majority of time that the universe has existed, there have been the requirements for life, at least as we know it. And while it's true that we might be the youngest kids on the block or among them, that seems unlikely. Because there could have been kids on the block, even if it took 4 billion years for kids to evolve from reproducing molecule, that could have happened 10 billion [00:15:00] years ago or 8 billion years ago. I suspect that there's a lot of intelligence out there that's far older than we are, and in fact that might be the easiest to find.

Paul Thies: Yeah. This is way above my pay grade, but if we could somehow figure out where the Big Bang took place, as in a place and time and space in the universe, and then as it expands, of course, time unfolds. So it's [00:15:30] like, if you could pin point what is "The center of the universe or where the Big Bang took place"-

Seth Shostak: Well, Paul-

Paul Thies: ... that would be where the life would be.

Seth Shostak: Yeah. But there is no such place. That's a mistake that people envision the Big Bang as happening 13 billion years ago, whatever. That there's this big dark room with nothing in it, and somewhere in that room, there was an explosion and then there's a Big Bang. But that's not the way it was. The Big Bang created this space. You can't find the center of [00:16:00] the Big Bang anymore than you can find the central place on Earth, on the surface of the Earth. It's a sphere. Every point is as good as any other point. So there is no center.

Paul Thies: Oh. Oh, wow. What a shame. But we'll have to work on that. My next question. I've got question for Seth and for Nathalie, and I'll start with you, Nathalie. What is one of the most surprising things you've learned in your career as an astrobiologist and explorer [00:16:30] of extreme environments?

Nathalie Cabrol: There are a number of them, but the thing that really sticks with me is that I still have to find a place where life isn't. It seems that when you get life started and we don't even know what that means, we don't know if it's a transition from [inaudible 00:16:51] to biology, or if it's something different, when you get started, you just cannot get rid of it. Life is a pest, as we all know by [00:17:00] now.

Paul Thies: All right. And then Seth, for you, what is one of the most surprising things you've learned in your career in astronomy?

Seth Shostak: Well, in astronomy, I think it was when I was a graduate student and I was studying a bunch of nearby galaxies. And one of the things that came out of that was to know how quickly they spin. Galaxies do spin, most of them anyhow. Right? And everybody expected that if you went to points that are very far from the center of the [00:17:30] galaxy, that the spinning would slow down. In the same way that Uranus, Neptune, Pluto, they all go around the sun at a slower rate than the inner planets. That's physics from 500 years ago, there's nothing surprising about that. But what was surprising for me, was that that wasn't true. And we found in the late 1960s as galaxies spun too quickly, clearly there was some mass in those galaxies that we couldn't [00:18:00] see.

Paul Thies: Wow. Yeah. This is mind boggling, some of the celestial mechanics at play. All right. So we're going to go to the audience-question portion. This first one is a question from Zach Alexander, Bristol, UK, and his question's for Seth. What is the simplest signal you would identify as being from an intelligence source?

Seth Shostak: [inaudible 00:18:24], that's a good question. And I applaud anybody from Bristol. Bristol has [00:18:30] a very nice bridge built by Isambard Kingdom Brunel, and it's still in use. It's a wonderful thing.

Anyhow, that aside, what kind of signal? Look, the sorts of signals we're looking for we tried to keep that as general as possible. Some people think, "Oh, you're looking for the Fibonacci Series, or you're looking for prime numbers or you're looking for pi or something like that." All of that now is that that's not right. [00:19:00] That's not what we do. We look for the technical characteristics of the signal. So fundamentally those boil down to one thing is the signal really at only one spot in the radio spectrum? If it's a radio experiment that we're doing. So is [inaudible 00:19:16] it at 1453.5 Megahertz on the dial or some other number, but not all over the dial, because if you have a Quasar or a Pulsar or anything else, radio noise made by Jupiter or the sun, those signals [00:19:30] are everywhere you look. You don't have to tune to a particular frequency. And so nature is not as good an engineer as an alien would be, that's the assumption.

Paul Thies: Okay. So an alien's going to be a much more directed signal. It's not just going to be scattershot all over the place, but it's-

Seth Shostak: That's something else. Whether they're directed toward us or some other part of the galaxy, that you can't say. But what we're looking for is a signal that's narrow band. I mean, you tune into your favorite, I don't know, radio station, and it's [00:20:00] had a particular spot on the dial. It's not all over the dial. That's the, if you will the indication of a transmitter and that's what we're looking for.

Paul Thies: Okay. I got you. All right. This next question is from Sam [Lao 00:20:15] from Boston, Massachusetts. And this is a question for Nathalie. Does SETI have a program to think about the larger ethical and philosophical implications if contact with alien intelligence is made?

Nathalie Cabrol: Yeah, we have [00:20:30] ethical question being looked after by a different level. The protocol for SETI exists, Seth can talk more about this. But there is a series of things that need to happen to verify a signal, et cetera. For the ethics of finding life, that goes from microbes to E.T. we cover the whole Drake equation here. For microbe there is what we call [00:21:00] planetary protection, try and understand how to prevent contamination when we go to another planet, just for scientific purposes in the first place. You don't want to travel a million miles and discover that terrestrial life is thriving all over the place, because we already know for instance that on Mars, some terrestrial microbes could survive there. So that's a reason as well why we're not landing. People are pulling their hair out [00:21:30] saying, "But you have eyes near the polar caps and it's right there. And you have eyes in high latitude. Why aren't you landing your spacecraft in those places?"

Well, that's the reason why. We have right now sterilization protocols that basically allow a spacecraft to leave for space with certain amount of micro per unit. Okay? A surface unit on the spacecraft. Then we know that we have done to the best [00:22:00] of our knowledge, the best we could to sterilize the spacecraft. And then if you land on Mars on the place where there is no ice or water too close to the surface, then considering the environmental condition on Mars, the spacecraft will be sterilized within a few days just because you have cosmic race and all of this good stuff falling at the surface.

And contamination goes both ways. We also don't want to bring back anything. Now, [00:22:30] the ethical question comes about what if we are finding life on any of the planetary bodies in the solar system? And right now, it still up for discussion, people are talking about this. Some of them are saying, "Well, leave Mars to the Martian. Fence the place, we're not going there." Others are saying, "Well, look at what happened in the history of humanity, it's never really good to be discovered."

[00:23:00] For when it comes to alien, the good thing about it is that they might want to impose their ethical views on us, because if they are making the journey to visit us, then that means that they are fairly more advanced, fairly more advanced than we are. I don't know about the ethics. I know that there is a lot of discussion, especially when you are starting to talk about religion, about this kind of things. It is an interesting debate. We have this chance [00:23:30] at the Institute to be working with the current and the previous director of the observatory of the Vatican and their astronomers, and they're wonderful, wonderful men. And we're discussing all of those things, but at this point in time it's at the level of the discussion.

Paul Thies: This next question is from Pamela Jordan in Greenville, South Carolina. And this one is for Seth. Beyond listening in the radio [00:24:00] spectrum, searching for light signals and searching for infrastructure, are there other detection technologies being considered by SETI?

Seth Shostak: I think she may have covered them all. We look for signals, radio signals. That's the traditional SETI approach. That's 60 years old now. We also look for, if you will, flashing lasers. We're building some infrastructure, people at the University of California, Berkeley are building some instruments as well [00:24:30] that could see a laser that happened to be aimed in our direction. That would be obviously another sign of intelligence. In general, you could say that while not looking for these things specifically, all astronomers who use telescopes are looking for E.T. too. Because if they were to find some giant engineering project, the Dyson spheres or something like that, giant construction that some civilization that's a million [00:25:00] years more advanced than we are has built, then they would say, "Well, I don't quite know what that is. Maybe it's aliens." And this has happened at least a half dozen times in the history of astronomy. It's never turned out to be aliens, but it's worth checking out because maybe one time it will be.

Paul Thies: Yeah. Interesting. Okay. This next question is for Nathalie. This is from Bejoy [Menathara 00:25:24] from Dubai, United Arab Emirates. And he writes, given that the SETI mission is to study [00:25:30] life in the universe, I'd like to know if SETI is involved in the study of life in oceanic trenches.

Nathalie Cabrol: Specifically in trenches, I don't think so. But we have one of our PIs, at least one of them, in a small team with him looking at life and environments for life in the ocean right next to [inaudible 00:25:54] off the coast of Oregon. Yes, of course.

Paul Thies: Okay. Excellent. And then [00:26:00] my last question, this was suggested by a number of folks, including Richard Lambert of Leeds, UK, Victor Le [Patillo 00:26:10] from Wokingham, UK, Claire Leevers from Sydney, Australia, and Tomash [Alakvieder 00:26:16] from Warsaw, Poland. They're all asking in kind of different angles, but about the Drake equation. And so it's been 60 years since Dr. Frank Drake gave the world the famed Drake equation, a probability formula [00:26:30] to estimate the presence of extraterrestrial civilizations. Now the formula retains widespread interest, admittedly many, if not most of its factors remain unknown. The question is, and this is for both of you all, why do you think the equation retains such fascination for people? And do you think we might crack some of its variables in our lifetime? We'll start with Nathalie and then Seth, you weigh in as well. I'm sure you both have some opinions here.

Nathalie Cabrol: First. [00:27:00] I would say that I would disagree with the fact that a lot of the factors at this point in time remain unknown. In fact, I think that's completely the opposite. We're starting to populate them very, very well. And to me, the beauty of the Drake equation it's in its simplicity and its flexibility because you can, even if you think of it, think about life as we don't know it, with the Drake equation. You just have to move [00:27:30] the habitable zone. You have to tweak the kind of initial parameters that you want to input in it. And also the other thing that makes me smile often is that, of course, because it's such a successful, and simple, and elegant way of approaching, what is actually the astrobiology roadmap from the origins of life to E.T. Right?

Is that there have been many attempts at adding something [00:28:00] or just tweaking something to get a different version, but all of them are just tweaks. They are not changing anything fundamentally to the Drake equation. And right now we know a lot better about habitable zone, we have been tweaking the notion of habitable zone. We have added a number of greenhouse gases, that actually changed [00:28:30] the place of the Earth a little bit. We know a lot more about the exoplanets today. We are making progress in terms of extreme environments on Earth, which tells us a lot more about life in the universe.

We also understand today that the habitable zone is not the only thing that is important when you are searching for life. You have habitable environment, which means that you can be way outside of the habitable zone and still have places where life [00:29:00] could exist. There are so many progresses being made in astronomy and also we are living experiment for the L-Factor. We are living it every single day today. So to me, the Drake equation is the gift that keeps on giving. I think that we will understand a lot better [inaudible 00:29:22] in the decades to come.

Paul Thies: Okay. Interesting. And then Seth, your take on the Drake equation.

Seth Shostak: Look, the Drake equation [00:29:30] was formulated not to be in the back of all the astronomy textbooks that it is in, which is to say all of them, all of them. It's the second most popular equation in science, so it is said, after E equals MC square. But Frank, he developed this equation, it was actually based on another equation that had been developed by an astronomer, a guy by the name of Harlow Shapley, doesn't matter. But it's a great way to organize [00:30:00] information. If you want to do a SETI experiment, it would be nice to at least know whether you're wasting your time or whether there's some chance of success, and that's what it was designed to do.

Now, unfortunately, there are several of the seven terms in the Drake equation that we really don't know. For example, if I give you a million planets like Earth, how many of them are actually going to cook up life? We don't know that yet. If we were to find other life in our own solar system, pond scum on Mars, for example, at least [00:30:30] then we would know that life is not so unusual. But that still doesn't tell you whether intelligent life is unusual or if it is, does it automatically if you will, self-destruct once it gets to the point of building powerful transmitters so we could find it. We don't know any of those things.

The last term, the L that Nathalie mentioned, the lifetime of a technological civilization. We really don't know, we've been technological for frankly, less than a hundred [00:31:00] years. What's going to happen? Are we going to wipe ourselves out? Maybe, depends on your point of view and our own actions. But if that becomes the case, if once you get to a certain technological level, now you can wipe yourself out and inevitably you do, then we're not going to find the aliens because they're all dead. So the Drake equation, it doesn't answer these questions, but it gives you the framework to discuss them.

Paul Thies: Oh, that's interesting. Yeah. [00:31:30] Because some of these things, it just seems like you can't know, or it surpasses our ability to know now. But like you said, it is a very interesting context to put forward so you ask the right questions.

Seth and Nathalie, I want to thank you both so much for your time today. This has been really fascinating and of course, I think it's pretty universal, people are pretty fascinated with the idea of the search for extraterrestrial life. [00:32:00] I appreciate you both very much for sharing your time today and your insights, so thank you so much.

Nathalie Cabrol: Thank you, Paul.

Seth Shostak: Thank you.