STEPHEN WEBB INTERVIEW PART TWO

Hello again, Ars Technica readers. This is the second installment of a three-part interview with British astronomer Stephen Webb on the subject of Fermi's paradox. If you haven't yet heard part one, there's a link on the page where this player's embedded, and I strongly suggest that you go back and listen to it before this one.

And with that - back to my conversation with Stephen Web. To remind you of where we are in the conversation, we left off just as Stephen and I were about to consider the second large set of plausible solutions to the paradox, which cluster around the notion that intelligent aliens ARE out there - but we just haven't been able to detect them yet.

Rob Reid: Which brings us to the second set of things, which is, they exist, but we have yet to see or hear from them, and maybe as a transition into that, we can talk briefly about the SETI project, because we have actually been listening very, very closely. So the significance of us not hearing from them is greater than it would have been if we hadn't been listening.

Stephen Webb: Indeed. We began by talking about the Drake equation. Well, Frank Drake wrote down that equation to give him some framework for thinking about this search for extraterrestrial intelligence. We're looking for signals, what do we want from a signal? You want it to go as fast as possible, your signal, so that implies light waves or gravitational waves. There's an economic argument, as well, presumably, you want it to be easy to produce your signals, so that rules out gravitational waves, because basically you need to shake a black hole vigorously to create gravitational waves, and neutrinos are hard to modulate. Light waves, electromagnetic waves, dead easy to produce. They go the fastest possible speed and they'll go where you want them to go.

Stephen Webb: So the search for extraterrestrial intelligence primarily, since Frank Drake initiated this, has been the search for electromagnetic radiation from possible extraterrestrial sources. Yes, so far the result is silence.

Rob Reid: It's worth noting that SETI has kind of meant a couple different things over time. It is an activity, the search for extraterrestrial intelligence, and as more and more energy gathered around this and as Frank Drake gathered more believers and interested people, it became formalized into, for a period of time it was actually US government funded, and then at some point, the SETI organization became a private donor backed organization, and so SETI is both an activity and it often refers to the SETI organization, which has been home to Frank for a long period of time, and has also been home to Jill Tartar who ran the SETI organization for many years. At the peak of their funding, Paul Allen helped them build a very large array of telescopes, so it ebbs and flows with the funding and so forth, but this activity of SETI has been formal and fairly rigorous and methodical. Thousands upon thousands of stars have been scanned on very, very, very wide sets of frequencies, and we have yet to pick up anything that seems to be in any way artificial in origin. All we've been hearing as we've been scanning these thousands of stars on these countless frequencies is just sort of static noise.

Stephen Webb: Absolutely. You have to listen to find out, and we are, and people have since Frank Drake initiated it, but it is very, very, very difficult. It's much more difficult than finding the proverbial needle in the haystack. We have to have our telescope looking at the right time in precisely the right direction at the right wavelength, it's a huge parameter space that we need to explore. You can imagine a telescope looking at the correct star, at the correct wavelength, but just not at the right time.

Rob Reid: Yeah.

Stephen Webb: So, who knows? We need to engage in SETI for a long time before we can really conclude that silence means silence.

Rob Reid: Yeah. Then there is the possibility that they are out there, but they're not broadcasting.

Stephen Webb: Absolutely. The flip side of SETI is METI, or active SETI, so messaging extraterrestrial intelligence. There's been some discussion amongst scientists, people like Stephen Hawking, about the wisdom of sending, broadcasting a signal, because it gives away your presence. I've heard it suggested that maybe actually everyone's too scared to broadcast, so maybe everyone's listening, no one's actually transmitting. There's a science fiction hypothesis called the Berserker hypothesis, that instead of seeking out new life and new civilization as Star Trek would have it, it's seek out new life, new civilization, and kill it. The idea being that if you kill all organic life out there, the galaxy is yours and all of that real estate. Maybe you don't want to take that risk.

Rob Reid: Yeah.

Stephen Webb: It could be that these 10,000 civilizations are all listening, waiting for the first move to come from someone else.

Rob Reid: Another possibility is they have fallen silent for completely benign reasons. Looking at our own civilization as we get more and more technically advanced, we are broadcasting less and less, and we are broadcasting in a less and less leaky manner. The way that TV and radio would broadcast many decades ago was blasting out electromagnetic waves in all directions, and now we're getting much more point to point with satellites, we're putting lots of things on fiber optic cables, and it's entirely possible that the noisy period of a civilization's history is only a few decades or maybe a century, which may well be the situation with us, correct?

Stephen Webb: Absolutely. I sense perhaps civilizations would want to go out and explore. Maybe, as virtual realities and virtual life becomes more and more common, maybe our own civilization will find it actually much more stimulating, interesting just to stay at home and explore those virtual realities as opposed to real realities. It seems plausible, looking at the way we're heading, that we're much more interested in inner space than outer space.

Rob Reid: Particularly when you think of the expense of getting to another star. For the cost that it would take us in terms of energy, risk, directing technological innovation, all that energy could go into, as you said, creating these virtual environments and things that are fascinating us more and more, particularly before Elon Musk came along and put the possibility of going to Mars on the near-term agenda. Certainly, when I read the first version of your book, that seemed overwhelmingly plausible to me because it was 2000, I think, when I first read it, it's been 30 years since we've been to the moon, we haven't been anywhere close to the moon since then. The year 2000, the Internet's getting better and better, you could see virtual reality on the intermediate horizon, and it was very, very easy to contemplate that we would just become a very inward lurking species. So it seemed then very, very plausible that a highly advanced civilization would be perfectly content on a pretty small sliver of their planet where they could access experiences, and wisdom, and philosophies that we could never contemplate merely by exploration of the galaxy.

Stephen Webb: That's right. A lot of these things, obviously, are dependent upon the technology that we're familiar with at a particular time. It's interesting, I think, that possible solutions to the Fermi paradox, they develop over time as our own technology developed.

Rob Reid: That is one of my favorite parts of the book is they exist, but we have yet to see or hear from them, there are literally dozes of solutions there, but we keep running into what you call cultural homogeneity. Which is, "Yeah, well, you could see why we might just end up surfing the net if Elon's project doesn't work out, and Oculus Rift 3.0 is really cool, we could see maybe even 5,000 of the 10,000 civilizations, but the presumption that 100%, all aliens and all circumstances at all times will choose to surf the net or do any one of the dozens of things in that large section of the book, it really falls down there.

Rob Reid: It just takes one exception and the universe is full, and it's not full.

Stephen Webb: Yeah. It just needs one civilization to follow the logic that, if we get out there first, the galaxy's ours.

Rob Reid: We win.

Stephen Webb: Yeah. We win.

Rob Reid: Yeah. This is an aside, there is this one rather fun thing that's going on. Would you like to talk just briefly about Tabby's Star and what the fun explanation is, and what is perhaps more plausible?

Stephen Webb: Yeah. It's a real astronomical mystery, it's great fun. It's the weirdest star in the galaxy. It's name Tabby's Star after Tabetha Boyajian, I believe is how you pronounce it.

Rob Reid: She's at Yale, right?

Stephen Webb: Yeah, that's right. It's about 1,280 light years from Earth. What makes it weird is that Kepler Space Telescope that's looking for these periodic dips in brightness is seeing dips in brightness from Tabby's Star, but they're not regular. They're small, they're frequent dips, but they're non-periodic. There's been two large dips, as well, about a 15% dimming and about a 22% dimming, I believe.

Rob Reid: These dimmings are completely inconsistent with what we see from planets, so whatever is occluding Tabby's Star on a periodic basis does not appear to be a planet, it appears to be very large, and it appears to be circling it or doing something at erratic intervals.

Stephen Webb: Yeah. If it were a Jupiter sized object that was transiting, you'd see a one percent dip in brightness. We're seeing lots of these small, non-periodic dips in brightness, it's not a planet going around in a regular orbit because it's non-periodic. Then you've got these two huge dips that are very difficult to imagine being a planet. It's not clear, at all, what's going on, stars just don't do this.

Rob Reid: Right.

Stephen Webb: You get variable stars, but they don't vary in this particular way, so what's going on?

Rob Reid: One fun explanation is that somebody is building a Dyson sphere, just a great big sphere that will eventually be complete and opaque, and capture 100% of the solar energy that this star throws off. That's something that people have talked about as being a plausible astro-engineering project for many decades now. That could be one fun explanation is like, "Someone's building that sucker right now."

Stephen Webb: It would be an incredible coincidence to be around just when someone's building one of these things so close.

Rob Reid: Right.

Stephen Webb: It's something that fits the observations. People have come up with possible explanations, a swarm of comets, perhaps, or maybe a really big, giant planet with a ring structure. None of these explanations somehow smell quite right, we don't know what's going on.

Rob Reid: I've seen a take-down, a debunking of the comet explanation, it was pretty persuasive.

Stephen Webb: Exactly. I think, at present, the answer is we don't know what's going on.

Rob Reid: For anybody who's listening to this and finds this intriguing, Google it, Tabby's Star, and follow the story, because it is ongoing.

Stephen Webb: Yes. I would urge all your listeners to Google this and keep on top of this story, because there will be other dips in brightness coming, if the past is anything to go by.

Rob Reid: Again, there are literally dozens of solutions that they exist, but we have yet to see or hear from them. To get to that third category now, the least fun one for fans of science fiction, in many obvious ways a very chilling explanation, but in more subtle ways, a very optimistic set of explanations, which is, there are no intelligent aliens in the galaxy, and perhaps, even the universe. That is, again, a collection of a couple dozen solutions. So, talk us through the big picture on that, please?

Stephen Webb: Well, we could just take the great silence at face value and say it's a silent universe because no one's out there, it's just us. One idea based around this is the idea of hard steps or difficult steps. Maybe, reaching the stage of advanced intelligence, it's like a 110 meter hurdle race, you've got to get over one hurdle, and then you've got to get over another hurdle, and then another one, in a certain order. You only need a few of those hard steps to make it unlikely that there'll be extraterrestrial intelligence. If it's a trillion to one shot, well, fine, there's a trillion planets, it's going to happen somewhere.

Rob Reid: And we're that one.

Stephen Webb: And we're that one. We don't know, for example, how dead matter becomes live. We've got some ideas, biologists have got some very good ideas, but we don't actually know. We do know actually that it happened really quickly on Earth, pretty much as soon as conditions were plausible for life to be here on Earth, life was here on Earth.

Rob Reid: That's one of the things that adds a great deal of energy to Fermi's paradox, because when you look at the four billion-ish year history of Earth, it is right about the very time where it first became possible for life to arise, that it happened here. We might have just gotten lucky in that case, that doesn't necessarily mean it's easy for non-life to arise from life, correct?

Stephen Webb: That's correct. It might mean that it's easy and that's what people have tended to think, but we can't say for sure. Because if it takes four billion years to involve intelligence, we have to find ourselves on a planet where life started early.

Rob Reid: Yeah.

Stephen Webb: So it's entirely possible that this transition from dead matter to life is one of those hard steps. What we need to do is try and find life elsewhere.

Rob Reid: Yeah.

Stephen Webb: If we can find life on Mars or Enceladus, it's a moon of Saturn, or on Titan, one of these places, if we can find life there and we can show that it evolved independently or came into being independently of evolution of life on Earth, then we know pretty much we're going to find life everywhere.

Rob Reid: Yeah. That would be kind of the equivalent of the Kepler telescope suddenly realizing, "Wow, there are a lot of planets in the habitable zone." We thought there may be, we really had no way of knowing in the 1950s when Frank Drake was first thinking about this stuff, now we have Kepler and we do have a way of knowing, but precisely the same way, if we find completely independently evolved life on Mars with a different code of life, something that clearly independently arose, then that will suggest vehemently that life does spring up kind of wherever it can, and we've solved yet another of the seven terms of the Drake equation in a positive manner.

Stephen Webb: Absolutely. We need to go out there and look, we have to. Another one would be the transition, the hard step potentially would be this transition from simple, single-celled life to complex multicellular life. What we do know is that here on Earth, life really didn't do much for billions of years, it was just basic, simple, single-celled life.

Rob Reid: That was about three billion years, correct?

Stephen Webb: Yes.

Rob Reid: We had this almost obscenely suspiciously immediate emergence of simple life, but once we had those single-celled critters, it was literally about three billion years of that and nothing else before anything more complex arose.

Stephen Webb: That's right and it was doing its own stuff, it was living, but it wasn't going to build a radio telescope.

Rob Reid: Right.

Stephen Webb: So maybe that's a difficult transition.

Rob Reid: Well, it certainly is from our experience. If it took three billion years, it's got to be highly improbably that it will happen on any given day, that the evidence we have from our own history certainly seems to show that, that is a giant, difficult, improbable step that takes lots of time.

Stephen Webb: Indeed. There are other possible difficult steps that people can come up with. So, the development of sexual reproduction or development of tool using, animals with big brains, and all that sort of stuff. You don't need many of those hard steps to make intelligent advanced civilizations out there to be rare.

Rob Reid: Yeah.

Stephen Webb: The possible chilling thing here is that we don't want to find multicellular life on Mars or on Enceladus or Titan, because that would imply that the hard steps are to come. Actually, the hard step right in front of us.

Rob Reid: Yeah.

Stephen Webb: If we find life elsewhere, it sort of implies that those things that we thought were hard are actually easy.

Rob Reid: Yep. If they don't exist, if we're in category three and they don't exist, there is something that is universally exterminating, either behind or ahead of us, and if it's behind us, well, thank goodness we got to multicellular life, nobody else got that far and now we've got a free run. But, if multicellular life kind of arises everywhere, that suggests that perhaps the hard thing is learning to live with nuclear weapons, or learning to live with synthetic biology or nanotechnology, could be the thing that no civilization gets past. If that's the case, we're probably doomed because what have we got that the other many thousands that went before us didn't have?

Stephen Webb: We've got to go with the odds and it wouldn't look so good. It doesn't look so good, frankly, does it, when you look at the political situation at present, but let's not be down.

Rob Reid: Yes.

Stephen Webb: Let's be optimistic.

Rob Reid: The other set of solutions in this broader category and I think you had about a dozen difficult steps, and we briefly touched on a couple of them and there are many others, is the so-called Rare Earth hypothesis or Rare Earth argument. Do you care to describe that briefly and talk a little bit about some of the solutions that live under that tent?

Stephen Webb: Okay, so Rare Earth is an idea came about from Peter Warden and Don Brownlee, I believe, there at University of Washington. You can think of it as essentially adding other factors into the Drake equation. It might be that you need a planet with a large moon. Earth is actually you could consider as a double planet because we have, compared to the size of the Earth, we have a large moon. The moon certainly seems to play a role in stabilizing Earth's axial tilt and giving us essentially good weather.

Rob Reid: Good, stable weather.

Stephen Webb: Good, stable weather. You can imagine a climate that goes between very, very hot, very, very cold, and that's the sort of rapid climate change that you would get if you don't have a stabilizing moon up there.

Rob Reid: Which might be a very exotic thing because we're the only double planet system in our solar system, so we're aware of several other planets, none of them have another relatively gigantic moon, so that does seem to be pretty scarce, and it may be incredibly scarce, for all we know.

Stephen Webb: Well, the thing about it is that the moon was created by a collision and it seems to have hit the sweet spot, it was an object the size of Mars smashed into Earth and the moon was the result. If that collision, the details of the collision, were slightly different, we'd have had maybe a slightly bigger moon or the smaller moon, and the moon seems to be just the right size for stabilizing various activities over a billions of years period.

Rob Reid: That starts becoming explanatory because if this kind of precisely correct collision resulted in this very unusually stable planetary system, which results in billions of years with fairly stable temperatures, and we need those billions of years in the vat to get from single-cellular to multicellular, it is entirely possible that without this perfect configuration of moon, you would not have had that stability.

Stephen Webb: That's right. If it's a one in trillion event, we have a trillion planets, it's going to happen somewhere. Another idea is that, quite different idea, is that Earth's been lucky in terms of dodging the various disasters that could have hit it. There hasn't been a very nearby supernova that could have caused a problem. We haven't been in the firing line of a gamma-ray burst.

Rob Reid: Tell me if I got this wrong, if a supernova were to occur within roughly a light year of your planet, it would pretty much sterilize the planet.

Stephen Webb: It's that order, yeah.

Rob Reid: We're fine because there's no star other than our own within a light year of us, but if you're living in the galactic core, which is actually where most stars are, they're close enough together that supernovas, being as frequent as they are, would tend to sterilize a very, very high percentage of those solar systems. So, a supernova going off during the four-ish billion year period that at least it took life to arise on Earth, most of the stars in the Milky Way are probably close enough to enough other stars that they would have been knocked out. Then this gamma-ray burst thing is just crazy. A gamma-ray burst could almost sterilize an entire galaxy, am I right?

Stephen Webb: Sure. It's funny you should mention that, actually, because just today, on the day of this interview, astronomers have released the first images from a gamma-ray burst explosion, but the explosion happened so far away, 10 billion years for the light to reach us. That's how bright these things are. They happen across the universe, but potentially they're so bright you can see them with the naked eye. They're incredibly, incredibly violent events. Imagine all the energy that the sun will generate in its entire lifetime and you release that in a few seconds, that how powerful these gamma-ray bursts are, and they just light up the universe.

Stephen Webb: They seem to be directed, so if you're outside of the cone of radiation, you'd be okay, but if you're in the cone, it's going to make toast of your planet. There seems to be one type of burst is created when you have a rapidly spinning, very high mass star, and it collapses in to form a black hole, and it spews out huge amounts of radiation. The other event seems to be when you have two neutron stars orbiting one another and then crashing in, colliding, into one another, again, generating huge amounts of energy.

Stephen Webb: They happen randomly, but roughly one a day somewhere in the universe.

Rob Reid: We're quite fortunate that one hasn't happened in our galaxy, because that would turn the lights out in a very, very big chunk of the galaxy. If it happens once a day and our planet is four billion years old, that is over a trillion days. At some point, the odds are not at all small that a gamma-ray burst would have gone off in our galaxy, and had that happened and had we been in the radiation cone, our entire experiment would have been ceased. So, you add that to the fact that we haven't been around a supernova and around the dozen-ish other terms that you talk about in Rare Earth, and you might, through those steps or through the difficult steps, come to the conclusion that we're probably the only ones who've squeaked through.

Stephen Webb: It's an argument, yeah.

Rob Reid: Yep, it's an argument. Let's talk about your argument. You have probably spent as much time thinking about solutions to Fermi's paradox as anybody, what is your solution? What do you find most satisfying when you think about all 75 possibilities?

Stephen Webb: Well, I don't find it satisfying. My preferred solution would be the solution that I guess most SETI astronomers would go along with, which is that we share the galaxy with lots of wonderful aliens and it's just a matter of time before we discover them. Then I'd be living in the science fiction universe of my childhood, which would be great, I'd love that. I think the solution that is going to turn out to be true, and I find it difficult to prove it, but I think what will turn out to be true is that we are alone. The more I think about it, the more I find it slightly strange that we even think that when we look out in the universe we're going to find species that are ... Let's look at it. They're going to have to be social creatures, individuals won't be communicating over interstellar distances, so we're looking for social creatures, we're looking for creatures with good manipulative abilities because they're going to have to build a spaceship or build a radio telescope.

Stephen Webb: They're going to inevitably therefore have to possess intelligence. They're going to have to posses a complex grammar so that they can communicate these complex issues with each other. They're going to have to understand math and science. All of these things, these all characteristics that define us, that define our species, so why should we find those characteristics out there when we don't actually find them anywhere else here on Earth? The closest would have been the neanderthals and the Denisovans, none of those characteristics did them any good, they died out. We are just one of a huge number of twigs on a vast branch, a vast bush of life. Evolution has created some incredible, beautiful organisms, exquisitely fine-tuned to living the life that they live, and we happen to be one of those very rare, very exotic, very wonderful outcomes of evolution.

Rob Reid: What's interesting about that, to me, is I have historically and instinctively find that to be a depressing possibility. When I first read Rare Earth, about the same time I read your book for the first time, it blew my mind because I think the arguments in it are very, very powerful, but instinctively, I do not want to believe in them because I, like you, love the idea of that densely populated galaxy. It feels depressing, but the thing about it that is actually optimistic gets back to where does that great filter exist, if in fact nothing is out there, is the great filter behind us or in front of us?

Rob Reid: The idea that we're the only critters like us to ever arise in our galaxy actually suggests that, that filter is behind us, and that actually raises the prospect significantly that we will get through our nuclear adolescence and our synthetic biology post-adolescence, and our nanotechnology post-adolescence, without destroying ourselves. It also gives us a very powerful sense of responsibility, doesn't it?

Stephen Webb: Absolutely. I think you've encapsulated it perfectly, Rob, that it does at first glance seem to be a depressing thought that it's just us, but it isn't without its optimism because we could be that civilization that goes out there, does the exploration, finds out what there is. Whether it's us or our descendants, might be some sort of hybrid between humanity and machines, who knows what it is, but if we understand the huge responsibility that we have to protect our planet, our civilization, just to protect this wonderful gift of intelligence and consciousness, I think if we can come to that realization, then a consideration of the Fermi paradox is actually quite important.

Rob Reid: Now, before we close, I want to touch on two things briefly. One thing that is kind of comparably astonishing when one wraps one's head around it, which is what we mentioned briefly at the top, the anthropic coincidences, we've talked about Rare Earth, the anthropic coincidences are almost like rare universe. It seems when one starts delving into the physics of the universe's creations and the way that certain variables are set, that the existence of a universe that could bear life is extravagantly improbable.

Stephen Webb: A consideration of anthropic coincidence, it's like a bad rash for a physicist, you try and ignore it, you try and ignore them, but you have to keep coming back and scratching at them. The problem is, we've got some incredibly good theories of physics, but they contain parameters and what physicists do is observe those parameters and then plug them into the [inaudible 01:05:07]. The thing is though that the theories would work just as well with any other value for these constants, but the resulting outcomes would be very different.

Stephen Webb: For instance, one of the parameters would be the strength of the nuclear force. You can ask, "Well, what would happen if the strength of the nuclear force were just maybe a couple of percent bigger? What would the universe look like?" Well, it would be very different. Hydrogen would have been consumed very, very quickly after the big bang and stars like our sun wouldn't now exist. Or if it were a few percent weaker, then fusion might not take place at all the way it does in the center of the sun, so the stars that we think are important for the existence of life, wouldn't exist.

Rob Reid: Right.

Stephen Webb: Another example is cosmological constant. Now, in the units in which physicists like to express these things, the cosmological constant is incredibly tiny, fine-tuned, it's about 10 to the minus 120, it's an odd point. Odd, odd, odd, odd, 120 zeros and then a one. In any sane world, we'd say that, that was zero, but it isn't zero, it's tiny, but it's non-zero, and that's impacting on the expansion of the universe. Now, you can ask yourself, what would happen if it were just fractionally bigger? Again, the universe would be very, very different because galaxies wouldn't form. If you look at these parameters that aren't defined by theory, it's something that we measure and put into our theories, it turns out that these parameters have to lie within certain small ranges.

Rob Reid: There's a lot of these variables, any one of which, and correct me if I'm wrong, really, there's no reason it had to be exactly what it is. After the big bang, these variables were essentially set. As far as we can tell, they were set kind of at random and it's about a dozen, right? Or something in that neighborhood?

Stephen Webb: It would depend on who you speak to. It could be as few as six, it could be as many as 30, so a dozen is a reasonable estimate.

Rob Reid: Most of them could have been anything and all of them seem immaculately tuned to permit things like stars, and galaxies, and therefore, us, to exist. When you run the numbers on them, I think Lee Smolin is one person who's done this, and he came up with a mind-bending estimate of the radical improbability of everything being dialed in just so, by chance. Just as we have a rare Earth, a universe that could support any life, really, as far as we can think of it, just seems radically improbable. It's like somebody set these dials just so.

Stephen Webb: Yeah. Smolin came up with a figure of a chance in one in 10 to the power 229 of just randomly choosing these parameters. That's a one followed by 229 zeroes, it's a massive, massive, massive number.

Rob Reid: It is far more than the number of subatomic particles in the observable universe, correct? Something like that?

Stephen Webb: Number of particles in the observable universe is in the order of 10 to the 80, so 10 to the power 229 is hugely, hugely, hugely more than that. If you believe [inaudible 01:08:41] to come up, well, buy a lottery ticket, it's not going to happen by chance. It seems to be, some sort of observation here that calls out for some sort of an explanation, the question is, what's the explanation?

Rob Reid: Did somebody set up the universe very carefully? Because it's just as unlikely that, I don't know, a Honda Civic would just sort of appear from the random collision of atoms, it seems improbable on that level, or are there lots and lots, and lots and lots of universes and we naturally find ourselves in one that can support us because we will not find ourselves in one that cannot?

Stephen Webb: Exactly. That's why it's a little bit of an awkward conversation sometimes to have because clearly, with a number like 10 to the 229, some people will say, "Obviously, this is evidence for intelligent design by a creator." It doesn't necessarily actually, I suppose, have to be some sort of religious overtone to that, you can imagine sufficiently advanced extraterrestrial intelligence, I guess, being the creator, or indeed, it's a fake universe and it's just one of these VR simulations, we touched on that before. Another possibility that you alluded to is this idea of the multiverse. String theory gives us this idea of there being 10 to 500 possible different universes that each work, according to string theory. Each of those universes would have different parameters. In some the cosmological constant would be huge, in others the number of dimensions would be different, electromagnetism would be stronger in some, nuclear force would be weaker in others. Everything is going to happen in ten to the 500 different universes. The anthropic principle would say, "Well, we have to find ourselves in one where life is possible, we would not find ourselves in one where life is impossible, by definition."

Rob Reid: Yep.

Stephen Webb: It's a slightly disappointing view, I think, because it sort of rules out the possibility of a deeper understanding. We are where we are just because we happen to be in one of those universes in this fast string landscape, string theory landscape, but it might be the best explanation that we get for this anthropic coincidence.

Rob Reid: It does make the improbability work because if you have 10 to the 500 things, something as rare as 10 to the 200 and something thing, will happen just in vast, vast, vast, vast, vast number of times. It's no longer, even though it is a rare possibility, it is no longer at all rare in gross numbers. That is a major part of humanity's scientific agenda, but for now, these are big, big questions that we don't have anywhere close to certainty about.

END INTERVIEW ELEMENT OF PART TWO

So Ars Technica listeners - here we conclude the second installment of my interview with Stephen Webb. Part three is coming tomorrow, which we'll open by discussing the exciting stuff that's coming soon in the search for extraterrestrial life - and in astronomy in general. An amazing set of telescopes, other hardware, probes and projects are in the pipeline.

As mentioned before, if you can't wait to hear the rest of the interview, you can just head on over to my site, at after-on.com. Or, type the words After On into your favorite podcast player, and scroll through the episodes to find this one, which originally ran on September 26th of last year. You'll also find lots of stuff about life sciences - above all, genomics and synthetic biology. Conversations about robotics, privacy and government hacking, cryptocurrency, astrophysics, drones, and a whole lot more.

Or, you could just join me tomorrow, here on Ars.