Astronomy Cast Episode 24:
So Where Are All The Aliens?

Fraser Cain: All right, so last week we talked about the Drake equation, which is an attempt by Frank Drake to nail down the variables that help potentially calculate the number of intelligent societies in our galaxy.

There's a pretty strong counter-argument: if there are intelligent societies in the Universe, where are they? How come we're not part of some galactic federation? Where's my warp drive? Pamela?

[Laughter]

Dr. Pamela Gay: Well, this is –

Fraser: Where are they?

Pamela: This is actually a fairly old question. It was first brought up by physicist Enrico Fermi back in 1950 over lunch where he basically sat, stopped and went "wait, where are they?" It seems that if we live in a Universe that's populated (or just, for that matter, live in a galaxy – our own Milky Way galaxy) that's populated by other intelligent societies, civilizations with advanced technologies, they should have (if they're old enough) been given the time to spread out and conquer all the habitable worlds and just, sort of like Rome spread out across Europe, it seems that those alien civilizations should've spilled out across our little barbarian planet and incorporated us into some great federation… and they haven't.

Fraser: It's not a question that we ask here on Earth. You might say, "Where are all the other human beings?" well, they're everywhere. Wherever you look, if you go outside, anywhere you look there are other humans because as human beings we've gone and really explored the Earth to every last corner. Why hasn't that happened in the Universe?

Pamela: This is a question that we've been trying to come up with good rationales for, and in this case by "we" I actually don't mean just the scientists, but here it actually starts to call in on the philosophers, on the animal behaviourists and all of the people who work on the psychology behind exploring the entire Universe.

We Earthlings like to go out and pretend that we're a virus and dominate every bit of land that can possibly support us, and even a few pieces of land that can't. But what's going on outside of our Earth?

Fraser: I think that we've got an interest in doing so; if we could we would colonize the whole galaxy. If we have the technology to do so – I don't think there's any question that we would have necessarily a will to do it. I think for most people watching Star Trek and Star Wars, it seems like a completely natural solution. Eventually we'll get the

technology, and eventually we'll hit up the stars, and eventually this galaxy (and eventually all galaxies) will be filled with human beings who are our ancestors or, well, the opposite of our ancestors.

[Laughter]

Pamela: And in that Star Trek Universe, as soon as we step foot off of our planet, we run into the Vulcans. Where are those real life Vulcans? We know there's a planet around Eta Erandi, which in the Star Trek universe is where Vulcan's located. But have they come out and explored? This raises the question that we approached last week of, are there other societies out there – is it just that we live in such an inhospitable galaxy that life is extraordinarily rare. Could it be that life is just starting to emerge throughout the galaxy? Could it be that other societies have already had a chance to kill themselves off? All these questions are things that we have to think about.

Fraser: Well I'm hoping we can teach a little astronomy here, so let's sort of start at the beginning. What are some possible reasons why there might not be any aliens out there?

Pamela: The first argument, scientifically, is that maybe life is just starting to emerge. We live on a planet around a fairly metal-rich star. There are lots of other planets out there that are metal-rich, but when exactly did planets start forming? It takes a certain amount of time, once a planet is formed, for life to be able to evolve to any sort of advanced state. We're not quite sure what sort of interplay you need between extinction events and lack of extinction events to get from a whole lot of bacteria to plants to dinosaurs to dead dinosaurs and mammals to big mammals to smaller humans taking over the planet one phase at a time.

Fraser: So we could treat this like a race, where the whole universe has been running the same race the same amount of time and we happen to have won the race so far.

Pamela: That's one possible argument. One of the problems with this is one of the basic tenets that we have is that we don't live in a special time or special place or special anything else. This is the Principle of Mediocrity.

To get past the mediocrity principle, we have to say, "Well, maybe its not that we're so much at a special place as we just got lucky." But lucky isn't mediocre, so we're sort of in this catch-22, of perhaps because of a different principle, the Anthropic principle (that says because there's life, there's life), we get around the mediocrity principle through an escape door. It's sort of this weird circular reasoning of "because there's life, there must be life, but we're not supposed to be in a special place but because there's life maybe we are in a special place.' This is where the philosophers get involved.

Fraser: Yeah, let them handle that.

[Laughter]

Okay, so I guess the point being that we're here, therefore there's life, yet where's all the rest of it? What are some reasons why? Maybe life can't get a foothold or intelligent life can't rise?

Pamela: Intelligent life is something that's hard to get to. It requires, first of all, life to start. That, I personally don't think is too difficult a thing, at least at the single-cell, nano-bacteria, and single-bacteria sort of level. But to get to intelligent life, you have to have all the right conditions, you have to have evolution taking place, and you have to have evolution that doesn't lead to just Bass. The world would be awfully sad if the most advanced thing on the planet was a Bass (that's a type of fish for people who are listening in a foreign language).

You have to have the right chain of events to get to intelligence. That intelligent life has to *also* be capable of the technology. So there's always the paradox. What if life evolved on a planet with a completely cloudy atmosphere and they never saw beyond their cloudy atmosphere to imagine a Universe beyond? What if life evolved under the ocean so you had a completely watery existence? Say you were trapped in the lower parts of the ocean, where life clung to the vents at the bottom of the ocean (the thermal heat vents like we have in our own oceans), but never reached the surface and never saw the sun. What would cause that sort of intelligent life to want to even try to go to outer space that it couldn't even see?

You have this problem where you have to not only *get* intelligent life, but you have to get intelligent life that's interested in exploring the cosmos. You can always have an intelligent society that, for philosophical or religious reasons decides they're just going to stay at home, or they're not going to let our electronic technology (or whatever surrogate they have for our modern internet age) take over. What if they decide that it *is* better to have a simpler life, without their moral equivalent of the cell phone and laptop computer? All these things can prevent whatever life might be out there from stepping out and spreading across the Universe.

Fraser: I guess that a more negative possibility is that intelligent just wipes itself out. We stand now, with the capacity to strike a pretty big blow to our whole civilization with nuclear weapons, with some kind of ecological catastrophe. Who knows what nano-technology is going to do? I think that's a possibility as well – you could get life that just gets to the point of high technology and then wipes itself off the Earth or off the planet and then the bacteria have to start again.

Pamela: That's exactly right. Imagine the worst case scenario of every paranoid person yelling on a street corner's worst nightmare of bird flu takes over, becomes airborne, global warming proves true, we lose large segments of our population to viruses and then lose all of the fisheries, the ocean levels rise and we're basically reduced to the point of society collapsing as everyone moves inward from the oceans.

If society truly collapsed on our planet, it would be very difficult for it to rebuild. All the easily accessible fuel reserves have been used up. The coal and oil we have left is hard to get to, the mineral deposits that we have left are hard to get to, and the biggest cities would end up underwater. It would be very hard for society on Earth to start from square one and build itself up to where it is today simply because if its easy to get to, we've already used it up completely.

Fraser: It's hard to go from campfires to off-shore oil platforms --

Pamela: Exactly

Fraser: --to get at the hard-to-extract oil. For sure, I think that's the one that, I think makes me pretty nervous. That there's some technological or ecological disaster that maybe is almost inevitable for life – you get to a certain point, you master the energy, the forces of nature, but you make a mistake and then that's that.

But, even so I think someone out there had to have figured out a way around that – had to have avoided that, had to have prevented something long enough to hit space. Once you hit space, I think it eases up your chances again, right? Then you've got hundreds of worlds where you can have an ecological disaster on one and it doesn't really matter.

Pamela: Exactly. So here you are, you and your family have piled into your spacecraft and you've travelled for 20, 30 years to get to the nearest habitable world at a somewhat-sane (but still far beyond our current capability) speed. After travelling for all of this time, you find yourself a nice rock to settle down on and you start agriculture, you start building cities, you start mining… is the very first thing you're going to do, to set up a massive industrial complex to start building new spacecraft so that as soon as your grandchildren are born you can pile them into a new spaceship to go take over the next planet that's 30 years away?

It seems to me that there'd be a certain delay time naturally built in to all but the most courageous explorers where, when you find a new planet you'd want to settle down and build your cities and once you've fully established yourself *then* start sinking the resources into sending resources to other worlds. Sending a colony ship off isn't an easy thing; you have to stock it, you have to put your best minds onto it and a very small colony isn't going to have a lot of resources that it can share with future generations on a planet it may never communicate with.

Fraser: I guess one of the other issues is that we discussed with the Drake Equation last week, we talked about how depending on how far apart the civilizations are, it might just be too difficult for them to even communicate with one another. They could be around us, but as you said its too slow, too difficult to get from world to world. Maybe you are just stuck on the world you live on, but then its so far away there's no really convenient way to communicate with any other world. There could be hundreds or thousands of intelligent civilizations in our galaxy; too hard to move, too hard to communicate.

Pamela: Some of those are just going to settle down and decide that they're tired of colonizing and maybe we'll get lucky and they'll get tired of colonizing before they reach us (Or unlucky, depending on your point of view, I guess).

Fraser: What are some other reasons that could be used to explain? Let's assume that on the one hand we talked about the fact that maybe there isn't any life at all, or that the life is getting smashed or killing itself or is unwilling or unable to communicate. Let's say that it *is* spreading around the galaxy. What could be some reasons why we're not being talked to them?

Pamela: It's basically the energy and endurance necessary to make it. Say that the other societies happened to have started off 180 degrees around the Milky Way from where we are. It takes time and energy to make it, and they might've decided, "We're going to very thoroughly settle our quadrant of the galaxy first." The energy needed to get all the way over to where we are is simply something they haven't expended yet.

We've had the technology to be able to go to Mars (if we pushed ourselves) for a long time. But we haven't. We've had the technology to send people to the Moon for longer than I've been alive and we haven't done it in my lifetime.

It takes energy and it takes national resources, planetary resources to explore space.

Fraser: That's one of those assumptions, that it's way more expensive to colonize space than we think. We already believe it to be tremendously expensive in terms of resources, in terms of what it would actually take to undertake such a journey, so it might be that it is in fact far less feasible than we can even imagine. It might be that it could take ten times the technology that we're expecting to actually be able to make that journey.

Pamela: Exactly. We're still trying to figure out how to get a human being to Mars and perhaps it's a non-linear thing, and I suspect it *is* a non-linear thing. The further you try and go it gets not just twice as hard when you double the distance, but 20 times harder when you double the distance, or 1 thousand times harder when you try and get to the next star. With each one of these new leaps, you have to develop entire new strategies, not just for the technology but trying to sell it to your society. "Okay, everyone needs to tighten their belts and conserve their metal because we're trying to send this thing off to a planet that it will be your children who hear if this machine's successful." That's a hard thing to sell to a society.

Fraser: We've been looking for life so far using the SETI – Search for Extra-Terrestrial Intelligence project. Shouldn't that have turned up something by now?

Pamela: One of the things that SETI pre-supposes is other societies are going to be leaking radio signals out their atmosphere much like we do. Well, what if people first developed communication using light instead, or what if they confine themselves to wired communication or to fibre-optic communication? What if their communications works in wavelengths that don't penetrate through their atmosphere?

All these different things can prevent societies from leaking their radio waves into outer space such that we'd see them. You'd have to leak an awful lot of radio waves before you're detectable. So if you have a mostly shielded society or – I keep returning to my underwater society because I don't see why a society couldn't emerge underwater – they just may not have the same technologies that we have that lead to the leaking of radio waves. It's an awful big Universe. We struggle to see to the other side of the Milky Way. There's always that problem that life could be too far away from us to easily detect.

Fraser: Or I suppose they're using some kind of communication channel that it hasn't even occurred to us yet. For us it seems quite natural – let's communicate with radio waves, let's communicate with light beams. Maybe there's something else. It really makes a lot of sense to communicate with either some other exotic – like, let's communicate with dark matter.

[Laughter]

Pamela: We don't even know the *forces* that we could use.

[More laughter]

Fraser: Right! We don't even know what it is, and yet maybe in 20 years it will be just like "duh, we should've been communicating with dark matter all along – it's great for communication." So once we hook up the dark matter telescopes and receivers then it all makes a lot of sense.

That's of course, insane for me to say that.

Pamela: Yes.

Fraser: The point being that something we don't quite understand, using it as some form of communication – or let's communicate with gravity.

Pamela: Or they've figured out how to control what neutrino masses stay and they can send neutrinos in packets where they look at what the three different species are. I don't know, there are all sorts of crazy things that we can speculate on figuring out how to control that currently we don't even understand how it works. All these things – I've heard people talk about potentially creating solid state memory for computers by controlling the spins of atoms and then reading off what spin different things have. That would allow amazing amounts of storage, but we don't have the technology to do that in a systematic (let alone a cheap) way right now.

There are so many things that we're still learning how to do. We're just a baby society in technology.

Fraser: The other possibility is that the energy involved to actually communicate (from what we understand) is immense. For you to broadcast out at a level that people can receive within a reasonable range is enormous – more than we can muster. It might be that civilizations never want to be able to commit that much energy to transmitting signals just for the chance of "is anybody out there?"

Pamela: And there's always the timescale problem of, "what if they communicate at such high frequencies that they can burst their entire codex of everything they know and have ever known – their entire history – in less than a second? What if they're extremely long lived and their entire society moves significantly slower such that the word "is" takes a hundred years to say?

Fraser: We wouldn't even notice the oscillations in the background of the radio waves.

Pamela: Exactly. So there are so many different things, and then there's always the problem – what if they're out there and they know we're here and we just happen to be trapped in some cosmic refuge where no one is allowed to trespass for fear of corrupting our society? What if we're zoo animals? These are all things that people have contemplated as possibilities.

Fraser: Like the prime directive from Star Trek, where they have some rule where they're not allowed to talk to us until we've achieved spaceflight on our own or (worse yet) they're not allowed to talk to us ever and they're not going to say why and it's just too bad for us.

Pamela: Exactly

Fraser: But anytime we send a spacecraft outside of our solar system it gets shot down.

[Laughter]

Pamela: That would be really bad!

Fraser: Yeah, that would be unfair.

This is going to be one of those depressing episodes.

Pamela: Yeah, this happens a lot. The Universe is just trying to kill us everyday in new and interesting ways – or in this case, *aliens* are trying to, but no, I don't really think that's happening.

There's always the case - here on Earth we have different places that we have set aside where no one is allowed to go unless they're with a guide and they're specially trained because we're trying to protect the few places that are left on our planet that are still unpolluted by humans.

What if we're in the part of the galaxy that some galactic empire (that is still being dreamed up by a science-fiction writer yet-to-be-born) what if that unknown galactic empire has set aside our part of the galaxy as a place to be left alone and untouched because it's the only place still left that hasn't been corrupted by that society's civilization?

Fraser: So we're unpolluted by swarms of nanobots.

Pamela: So we're being left alone to just destroy ourselves *completely* independently.

Fraser: With our nanobots of our own creation.

Pamela: Exactly.

Fraser: Right.

I guess another possibility then is that they're here, but we just can't, somehow, interact with them.

Pamela: Or perhaps we interact with them everyday and we don't even know it. I don't think that's true either, but its still a possibility while we're playing with all of parameter space.

[Laughter]

Fraser: All of the possibilities that could be

Pamela: Exactly.

[Laughter]

Fraser: Right.

So then, of all of that vast list of possibilities, which do you like?

Pamela: I think that societies are just starting to spring up and that they're very rare. I think that when intelligent societies are born they're just as likely to kill themselves off during that coming-of-age industrial revolution period, as they are to survive it and thrive. I think that it's going to take, perhaps millennia, perhaps millions of years, before what few societies might be in this galaxy have a chance to actually correspond with one another. I don't know if our society is going to be one of those that actually survives its industrial revolution period, but I think every generation thinks it's the last generation. We'll have to see what our planet has in store in the next 40-50 years.

Fraser: I think I'm the hopeful one then.

[Laughter]

I think for me, logically, most of those don't really fly for me. I think that – I read a calculation; someone said it would take a million years to colonize the entire Milky Way, once you got rolling. The time to set down new colonies and then send probes to other stars – once intelligent life evolves, it wouldn't take long to colonize the entire galaxy with technologies that we kind of understand, not that we can create but we understand the physics involved and nothing rules it out.

So I'm kind of leaning to toward the rare Earth hypothesis, which is more that intelligent life, or complex life, is extremely rare. Maybe 1 per galaxy, or maybe one per galaxy cluster, or maybe just one.

I feel for me, logically every other possibility would end up in a Universe teeming with life.

Pamela: One thing that always gets me about this discussion is right now we don't have the technology to find other planets like Earth around other stars. We're *almost* there, but we're not quite there yet. The civilizations that we could detect because of their radio emissions would have to be a whole lot more either radio-loud or technologically advanced than we are. Right now we're trying to find life more advanced than our own, that lives on planets we can't yet detect. It's one of these places where we're just on the very edge of understanding and just trying to grasp at what we can. I think, in our lifetimes, so much is going to change that if we have this same discussion 20 years from now, we'll have a lot more answers than we have right now at least in terms of what planets are out there.

Fraser: I'll be interested to hear what the listeners think because this is one of those topics that there is no evidence for. Without evidence, the mind is free to wander. So, I'd love to hear what people think, where do they stand? What's your vote? Let us know and we can compile it and maybe we'll mention it in a future show what most people – maybe we should have a vote somewhere or on the forum.

[Laughter]

I'd be interested to know what people think. It's a neat concept to go into and to logically think through each possibility and think, "what are the implications of that, what would happen, what would the universe look like if this was the case?" I find that really interesting.

Pamela: Yeah, and unfortunately we're currently working from a data set of one.

When the first solar systems other than our own were discovered, we realised our entire model of how solar systems formed was wrong. Not entirely wrong, but it had some major problems. I wonder what's going to happen as we learn more and more. It's interesting times.

Fraser: Yeah, okay. All right. That was good; I think this was one of our more philosophical episodes.

[Laughter]

I hope you people enjoy it because its less of the facts and more of the philosophy, but don't worry we'll get more hard astronomy next week.

This transcript is not an exact match to the audio file. It has been edited for clarity.