The Fermi Paradox

May 21, 2014 By Tim Urban

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Everyone feels something when they're in a really good starry place on a really good starry night and they look up and see this:

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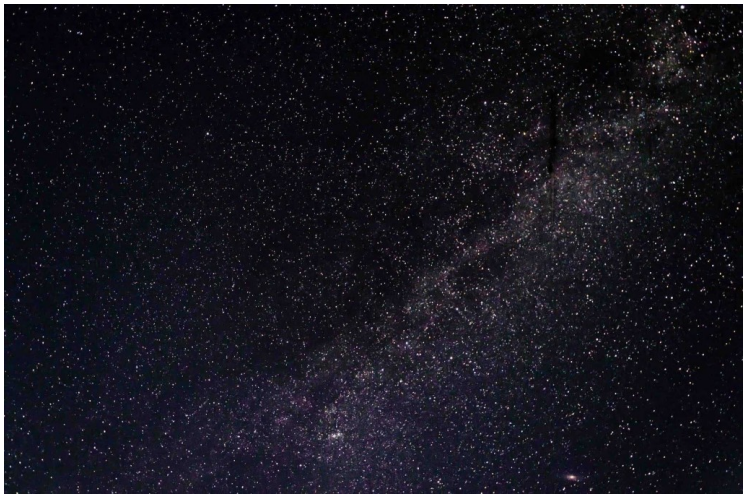


Some people stick with the traditional, feeling struck by the epic beauty or blown away by the insane scale of the universe. Personally, I go for the old "existential meltdown followed by acting weird for the next half hour." But everyone feels *something*.

Physicist Enrico Fermi felt something too—"Where is everybody?"

A really starry sky seems *vast*—but all we're looking at is our very local neighborhood. On the very best nights, we can see up to about 2,500 stars (roughly one hundred-millionth of the stars in our galaxy), and almost all of them are less than 1,000 light years away from us (or 1% of the diameter of the Milky Way). So what we're really looking at is this:

Galaxy image: Nick Risinger

When confronted with the topic of stars and galaxies, a question that tantalizes most humans is, "Is there other intelligent life out there?" Let's put some numbers to it—

As many stars as there are in our galaxy (100 – 400 billion), there are roughly an equal number of galaxies in the observable universe—so for every star in the colossal Milky Way, there's a whole *galaxy* out there. All together, that comes out to the typically quoted range of **between 10^{22} and 10^{24} total stars**, which means that for every grain of sand on every beach on Earth, there are *10,000 stars* out there.

The science world isn't in total agreement about what percentage of those stars are "sun-like" (similar in size, temperature, and luminosity)—opinions typically range from 5% to 20%. Going with the most conservative side of that (5%), and the lower end for the number of total stars (10^{22}), gives us 500 quintillion, or **500 billion billion sun-like stars.**

There's also a debate over what percentage of those sun-like stars might be orbited by an Earth-like planet (one with similar temperature conditions that could have liquid water and potentially support life similar to that on Earth). Some say it's as high as 50%, but let's go with the more conservative 22% that came out of a recent PNAS study. That suggests that there's a potentially-habitable Earth-like planet orbiting at least 1% of the total stars in the universe—a total of **100 billion billion Earth-like planets.**

So there are *100 Earth-like planets* for every grain of sand in the world. Think about that next time you're on the beach.

Moving forward, we have no choice but to get completely speculative. Let's imagine that after billions of years in existence, 1% of Earth-like planets develop life (if that's true, every grain of sand would represent one planet with life on it). And imagine that on 1% of *those* planets, the life advances to an intelligent level like it did here on Earth. That would mean there were 10 quadrillion, or **10 million billion intelligent civilizations in the observable universe.**

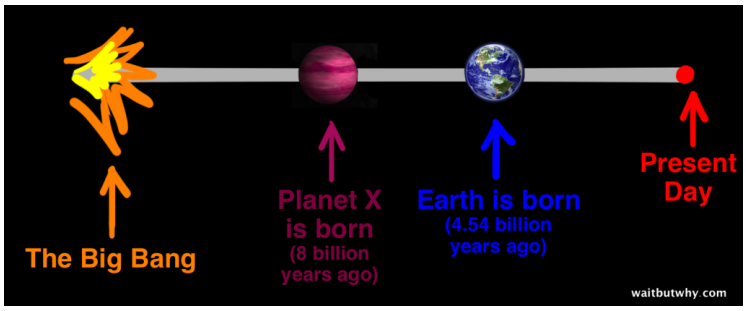
Moving back to just our galaxy, and doing the same math on the lowest estimate for stars in the Milky Way (100 billion), we'd estimate that there are **1 billion Earth-like planets and 100,000 intelligent civilizations in our galaxy.**[1]

SETI (Search for Extraterrestrial Intelligence) is an organization dedicated to listening for signals from other intelligent life. If we're right that there are 100,000 or more intelligent civilizations in our galaxy, and even a fraction of them are sending out radio waves or laser beams or other modes of attempting to contact others, shouldn't SETI's satellite dish array pick up all kinds of signals?

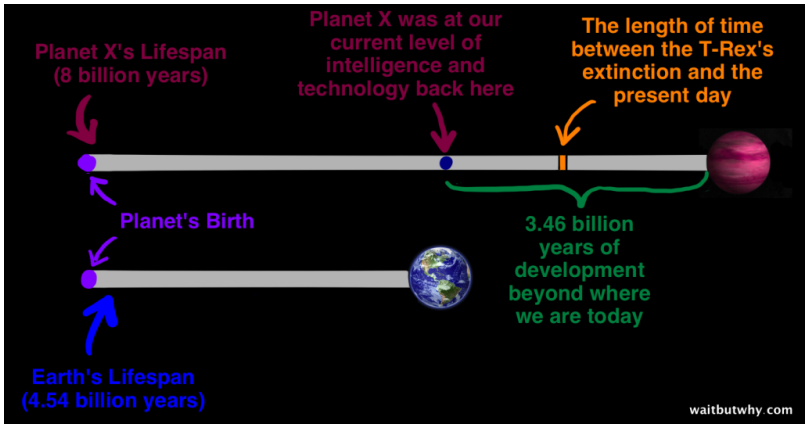
But it hasn't. Not one. Ever.

Where is everybody?

It gets stranger. Our sun is relatively young in the lifespan of the universe. There are far older stars with far older Earth-like planets, which should in theory mean civilizations far more advanced than our own. As an example, let's compare our 4.54-billion-year-old Earth to a hypothetical 8-billion-year-old Planet X.



If Planet X has a similar story to Earth, let's look at where their civilization would be today (using the orange timespan as a reference to show how huge the green timespan is):

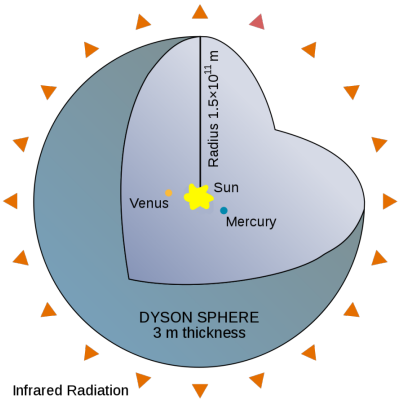


The technology and knowledge of a civilization only 1,000 years ahead of us could be as shocking to us as our world would be to a medieval person. A civilization 1 million years ahead of us might be as incomprehensible to us as human culture is to chimpanzees. And Planet X is 3.4 *billion* years ahead of us...

There's something called The Kardashev Scale, which helps us group intelligent civilizations into three broad categories by the amount of energy they use:

A **Type I Civilization** has the ability to use all of the energy on their **planet**. We're not quite a Type I Civilization, but we're close (Carl Sagan created a formula for this scale which puts us at a Type 0.7 Civilization).

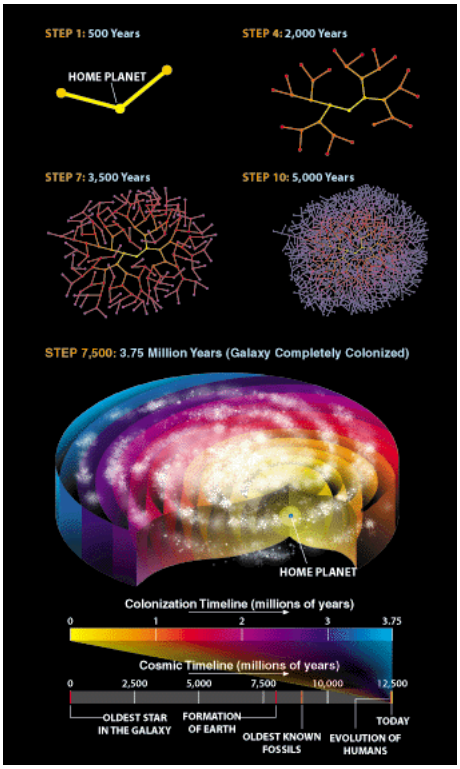
A **Type II Civilization** can harness all of the energy of their **host star**. Our feeble Type I brains can hardly imagine how someone would do this, but we've tried our best, imagining things like a Dyson Sphere.



A **Type III Civilization** blows the other two away, accessing power comparable to that of **the entire Milky Way galaxy**.

If this level of advancement sounds hard to believe, remember Planet X above and their 3.4 *billion* years of further development. If a civilization on Planet X were similar to ours and were able to survive all the way to Type III level, the natural thought is that they'd probably have mastered inter-stellar travel by now, possibly even colonizing the entire galaxy.

One hypothesis as to how galactic colonization could happen is by creating machinery that can travel to other planets, spend 500 years or so self-replicating using the raw materials on their new planet, and then send two replicas off to do the same thing. Even without traveling anywhere near the speed of light, this process would colonize the whole galaxy in 3.75 million years, a relative blink of an eye when talking in the scale of billions of years:



Source: Scientific American: "Where Are They"

Continuing to speculate, if 1% of intelligent life survives long enough to become a potentially galaxy-colonizing Type III Civilization, our calculations above suggest that there should be at least 1,000 Type III Civilizations in our galaxy alone—and given the power of such a civilization, their presence would likely be pretty noticeable. And yet, we see nothing, hear nothing, and we're visited by no one.

So where is everybody?

Welcome to the Fermi Paradox.

We have no answer to the Fermi Paradox—the best we can do is "possible explanations." And if you ask ten different scientists what their hunch is about the correct one, you'll get ten different answers. You know when you hear about humans of the past debating whether the Earth was round or if the sun revolved around the Earth or thinking that lightning happened because of Zeus, and they seem so primitive and in the dark? That's about where we are with this topic.

In taking a look at some of the most-discussed possible explanations for the Fermi Paradox, let's divide them into two broad categories—those explanations which assume that there's no sign of Type II and Type III Civilizations because there *are* none of them out there, and those which assume they're out there and we're not seeing or hearing anything for other reasons.

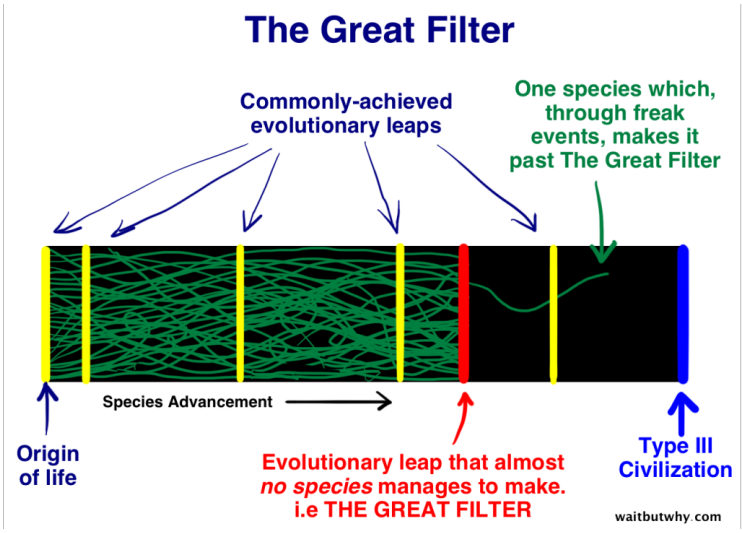
Explanation Group 1: There are no signs of higher (Type II and III) civilizations because there *are* no higher civilizations in existence.

Those who subscribe to Group 1 explanations point to something called the non-exclusivity problem, which rebuffs any theory that says, "There are higher civilizations, but none of them have made any kind of contact with us because they all ____." Group 1 people look at the math, which says there should be *so* many thousands (or millions) of higher civilizations, that at least *one* of them would be an exception to the rule. Even if a theory held for 99.99% of higher civilizations, the other .01% would behave differently and we'd become aware of their existence.

Therefore, say Group 1 explanations, it must be that there are no super-advanced civilizations. And since the math suggests that there are *thousands* of them just in our own galaxy, *something else must be going on*.

This something else is called **The Great Filter.**

The Great Filter theory says that at some point from pre-life to Type III intelligence, there's a wall that all or nearly all attempts at life hit. There's some stage in that long evolutionary process that is extremely unlikely or impossible for life to get beyond. That stage is The Great Filter.

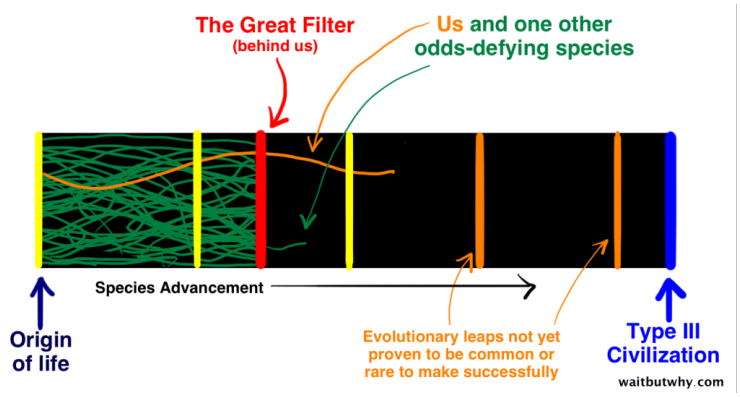


If this theory is true, the big question is, *Where in the timeline does the Great Filter occur?*

It turns out that when it comes to the fate of humankind, this question is very important. Depending on where The Great Filter occurs, we're left with three possible realities: **We're rare, we're first, or we're fucked.**

1. We're Rare (The Great Filter is *Behind* Us)

One hope we have is that The Great Filter is behind us—we managed to *surpass* it, which would mean it's *extremely rare* for life to make it to our level of intelligence. The diagram below shows only two species making it past, and we're one of them.



This scenario would explain why there are no Type III Civilizations...but it would also mean that *we* could be one of the few exceptions now that we've made it this far. It would mean we have hope. On the surface, this sounds a bit like people 500 years ago suggesting that the Earth is the center of the universe—it implies that we're *special*. However, something scientists call "observation selection effect" suggests that anyone who is pondering their own rarity is inherently part of an intelligent life "success story"—and whether they're actually rare or quite common, the thoughts they ponder and conclusions they draw will be identical. This forces us to admit that being special is at least a possibility.

And if we are special, when exactly did we become special—i.e. *which step did we surpass that almost everyone else gets stuck on?*

One possibility: The Great Filter could be at the very beginning—it might be incredibly unusual for life to begin at all. This is a candidate because it took about a billion years of Earth's existence to finally happen, and because we have tried extensively to replicate that event in labs and have never been able to do it. If this is indeed The Great Filter, it would mean that not only is there no intelligent life out there, there may be *no other life at all.*

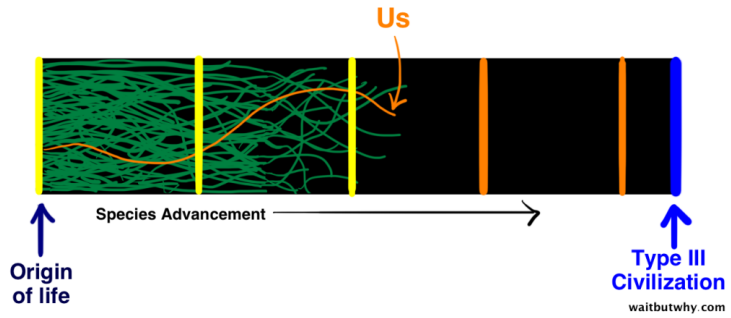
Another possibility: The Great Filter could be the jump from the simple prokaryote cell to the complex eukaryote cell. After prokaryotes came into being, they remained that way for almost *two billion* years before making the evolutionary jump to being complex and having a nucleus. If this is The Great Filter, it would mean the universe is teeming with simple prokaryote cells and almost nothing beyond that.

There are a number of other possibilities—some even think the most recent leap we've made to our current intelligence is a Great Filter candidate. While the leap from semi-intelligent life (chimps) to intelligent life (humans) doesn't at first seem like a miraculous step, Steven Pinker rejects the idea of an inevitable "climb upward" of evolution: "Since evolution does not strive for a goal but just happens, it uses the adaptation most useful for a given ecological niche, and the fact that, on Earth, this led to technological intelligence only once so far may suggest that this outcome of natural selection is rare and hence by no means a certain development of the evolution of a tree of life."

Most leaps do *not* qualify as Great Filter candidates. Any possible Great Filter must be one-in-a-billion type thing where one or more total freak occurrences need to happen to provide a crazy exception—for that reason, something like the jump from single-cell to multi-cellular life is ruled out, because it has occurred as many as 46 times, in isolated incidents, just on this planet alone. For the same reason, if we were to find a fossilized eukaryote cell on Mars, it would rule the above "simple-to-complex cell" leap out as a possible Great Filter (as well as anything before that point on the evolutionary chain)—because if it happened on *both* Earth and Mars, it's almost definitely not a one-in-a-billion freak occurrence.

If we are indeed rare, it could be because of a fluky biological event, but it also could be attributed to what is called the **Rare Earth Hypothesis**, which suggests that though there may be many Earth-*like* planets, the *particular* conditions on Earth—whether related to the specifics of this solar system, its relationship with the moon (a moon that large is unusual for such a small planet and contributes to our particular weather and ocean conditions), or something about the planet itself—are exceptionally friendly to life.

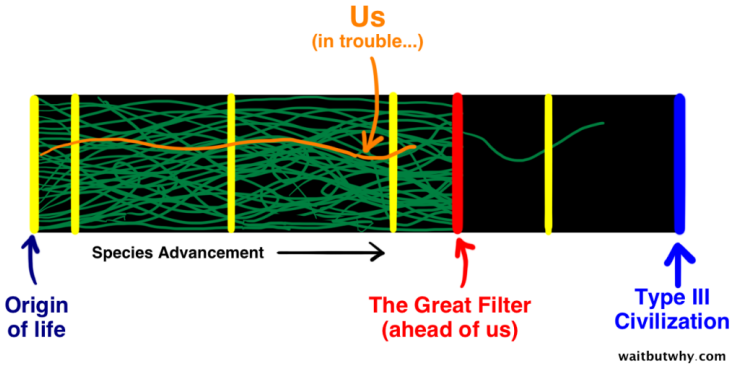
2. We're the First



For Group 1 Thinkers, if the Great Filter is *not* behind us, the *one* hope we have is that conditions in the universe are just recently, for the first time since the Big Bang, reaching a place that would allow intelligent life to develop. In that case, we and many other species may be *on our way* to super-intelligence, and it simply hasn't happened yet. We happen to be here at the right time to become one of the first super-intelligent civilizations.

One example of a phenomenon that could make this realistic is the prevalence of gamma-ray bursts, insanely huge explosions that we've observed in distant galaxies. In the same way that it took the early Earth a few hundred million years before the asteroids and volcanoes died down and life became possible, it could be that the first chunk of the universe's existence was full of cataclysmic events like gamma-ray bursts that would incinerate everything nearby from time to time and prevent any life from developing past a certain stage. Now, perhaps, we're in the midst of an astrobiological phase transition and this is the first time any life has been able to evolve for this long, uninterrupted.

3. We're Fucked (The Great Filter is *Ahead* of Us)



If we're neither rare nor early, Group 1 thinkers conclude that The Great Filter *must* be in our future. This would suggest that life regularly evolves to where we are, but that *something* prevents life from going much further and reaching high intelligence in almost all cases—and we're unlikely to be an exception.

One possible future Great Filter is a regularly-occurring cataclysmic natural event, like the above-mentioned gamma-ray bursts, except they're unfortunately not done yet and it's just a matter of time before all life on Earth is suddenly wiped out by one. Another candidate is the possible inevitability that nearly all intelligent civilizations end up destroying themselves once a certain level of technology is reached.

This is why Oxford University philosopher Nick Bostrom says that "no news is good news." The discovery of even simple life on Mars would be devastating, because it would cut out a number of potential Great Filters *behind* us. And if we were to find fossilized *complex* life on Mars, Bostrom says "it would be by far the worst news ever printed on a newspaper cover," because it would mean The Great Filter is almost definitely *ahead* of us—ultimately dooming the species. Bostrom believes that when it comes to The Fermi Paradox, "the silence of the night sky is golden."

Explanation Group 2: Type II and III intelligent civilizations *are* out there—and there are logical reasons why we might not have heard from them.

Group 2 explanations get rid of any notion that we're rare or special or the first at anything—on the contrary, they believe in the Mediocrity Principle, whose starting point is that there is nothing unusual or rare about our galaxy, solar system, planet, or level of intelligence, until evidence proves otherwise. They're also much less quick to assume that the *lack* of evidence of higher intelligence beings is evidence of their nonexistence—emphasizing the fact that our search for signals stretches only about 100 light years away from us (0.1% across the galaxy) and suggesting a number of possible explanations. Here are 10:

Possibility 1) Super-intelligent life could very well have already visited Earth, but before we were here. In the scheme of things, sentient humans have only been around for about 50,000 years, a little blip of time. If contact happened before then, it might have made some ducks flip out and run into the water and that's it. Further, recorded history only goes back 5,500 years—a group of ancient hunter-gatherer tribes may have experienced some *crazy* alien shit, but they had no good way to tell anyone in the future about it.

Possibility 2) The galaxy has been colonized, but we just live in some desolate rural area of the galaxy. The Americas may have been colonized by Europeans long before anyone in a small Inuit tribe in far northern Canada realized it had happened. There could be an urbanization component to the interstellar dwellings of higher species, in which all the neighboring solar systems in a certain area are colonized and in communication, and it would be impractical and purposeless for anyone to deal with coming all the way out to the random part of the spiral where we live.

Possibility 3) The entire concept of physical colonization is a hilariously backward concept to a more advanced species. Remember the picture of the Type II Civilization above with the sphere around their star? With all that energy, they might have created a perfect environment for themselves that satisfies their every need. They might have crazy-advanced ways of reducing their need for resources and zero interest in leaving their happy utopia to explore the cold, empty, undeveloped universe.

An even more advanced civilization might view the *entire physical world* as a horribly primitive place, having long ago conquered their own biology and uploaded their brains to a virtual reality, eternal-life paradise. Living in the physical world of biology, mortality, wants, and needs might seem to them the way we view primitive ocean species living in the frigid, dark sea. FYI, thinking about another life form having bested mortality makes me incredibly jealous and upset.

Possibility 4) There are scary predator civilizations out there, and most intelligent life knows better than to broadcast any outgoing signals and advertise their location. This is an unpleasant concept and would help explain the lack of any signals being received by the SETI satellites. It also means that we might be the super naive newbies who are being *unbelievably* stupid and risky by ever broadcasting outward signals. There's a debate going on currently about whether we should engage in METI (Messaging to Extraterrestrial Intelligence—the reverse of SETI) or not, and most people say we should not. Stephen Hawking warns, "If aliens visit us, the outcome would be much as when Columbus landed in America, which didn't turn out well for the Native Americans." Even Carl Sagan (a general believer that any civilization advanced enough for interstellar travel would be altruistic, not hostile) called the practice of METI "deeply unwise and immature," and recommended that "the newest children in a strange and uncertain cosmos should listen quietly for a long time, patiently learning about the universe and comparing notes, before shouting into an unknown jungle that we do not understand." Scary. [1]

Possibility 5) There's only one instance of higher-intelligent life—a "superpredator" civilization (like humans are here on Earth)—that is *far* more advanced than everyone else and keeps it that way by exterminating any intelligent civilization once they get past a certain level. This would suck. The way it might work is that it's an inefficient use of resources to exterminate all emerging intelligences, maybe because most die out on their own. But past a certain point, the super beings make their move—because to them, an emerging intelligent species becomes like a virus as it starts to grow and spread. This theory suggests that whoever was the *first* in the galaxy to reach intelligence won, and now no one else has a chance. This would explain the lack of activity out there because it would keep the number of super-intelligent civilizations to just one.

Possibility 6) There's plenty of activity and noise out there, but our technology is too primitive and we're listening for the wrong things. Like walking into a modern-day office building, turning on a walkie-talkie, and when you hear no activity (which of course you wouldn't hear because everyone's texting, not using walkie-talkies), determining that the building must be empty. Or maybe, as Carl Sagan has pointed out, it could be that our minds work exponentially faster or slower than another form of intelligence out there—e.g. it takes them 12 years to say "Hello," and when we hear that communication, it just sounds like white noise to us.

Possibility 7) We *are* receiving contact from other intelligent life, but the government is hiding it. The more I learn about the topic, the more this seems like an idiotic theory, but I had to mention it because it's talked about so much.

Possibility 8) Higher civilizations are aware of us and observing us (AKA the "Zoo Hypothesis"). As far as we know, super-intelligent civilizations exist in a tightly-regulated galaxy, and our Earth is treated like part of a vast and protected national park, with a strict "Look but don't touch" rule for planets like ours. We wouldn't notice them, because if a far smarter species wanted to observe us, it would know how to easily do so without us realizing it. Maybe there's a rule similar to the *Star Trek's* "Prime Directive" which prohibits super-intelligent beings from making any open contact with lesser species like us or revealing themselves in any way, until the lesser species has reached a certain level of intelligence.

Possibility 9) Higher civilizations are here, all around us. But we're too primitive to perceive them. Michio Kaku sums it up like this:

Let's say we have an anthill in the middle of the forest. And right next to the anthill, they're building a ten-lane super-highway. And the question is "Would the ants be able to understand what a ten-lane super-highway is? Would the ants be able to understand the technology and the intentions of the beings building the highway next to them?"

So it's not that we can't pick up the signals from Planet X using our technology, it's that we can't even comprehend what the beings from Planet X *are* or what they're trying to do. It's *so* beyond us that even if they really wanted to enlighten us, it would be like trying to teach ants about the internet.

Along those lines, this may also be an answer to "Well if there are so many fancy Type III Civilizations, why haven't they contacted us yet?" To answer that, let's ask ourselves—when Pizarro made his way into Peru, did he stop for a while at an anthill to try to communicate? Was he magnanimous, trying to help the ants in the anthill? Did he become hostile and slow his original mission down in order to smash the anthill apart? Or was the anthill of complete and utter and eternal irrelevance to Pizarro? That might be our situation here.

Possibility 10) We're completely wrong about our reality. There are a lot of ways we could just be *totally* off with everything we think. The universe might appear one way and be something else entirely, like a hologram. Or maybe *we're* the aliens and we were planted here as an experiment or as a form of fertilizer. There's even a chance that we're all part of a computer simulation by some researcher from another world, and other forms of life simply weren't programmed into the simulation.

As we continue along with our possibly-futile search for extraterrestrial intelligence, I'm not really sure what I'm rooting for. Frankly, learning either that we're officially alone in the universe or that we're officially joined by others would be creepy, which is a theme with all of the surreal storylines listed above—*whatever* the truth actually is, it's mindblowing.

Beyond its shocking science fiction component, The Fermi Paradox also leaves me with a deep humbling. Not just the normal "Oh yeah, I'm microscopic and my existence lasts for three seconds" humbling that the universe always triggers. The Fermi Paradox brings out a sharper, more personal humbling, one that can only happen after spending hours of research hearing your species' most renowned scientists present *insane* theories, change their minds again and again, and wildly contradict each other—reminding us that future generations will look at us the same way we see the ancient people who were *sure* that the stars were the underside of the dome of heaven, and they'll think "Wow they really had *no* idea what was going on."

Compounding all of this is the blow to our species' self-esteem that comes with all of this talk about Type II and III Civilizations. Here on Earth, we're the king of our little castle, proud ruler of the huge group of imbeciles who share the planet with us. And in this bubble with no competition and no one to judge us, it's rare that we're ever confronted with the concept of being a dramatically inferior species to anyone. But after spending a lot of time with Type II and III Civilizations over the past week, our power and pride are seeming a bit David Brent-esque.

That said, given that my normal outlook is that humanity is a lonely orphan on a tiny rock in the middle of a desolate universe, the humbling fact that we're probably not as smart as we think we are, and the possibility that a lot of what we're sure about might be wrong, sounds wonderful. It opens the door just a crack that maybe, *just maybe*, there might be more to the story than we realize.

Three more Wait But Why mind-benders:

How (and Why) SpaceX Will Colonize Mars – A post I got to work on with Elon Musk and one that reframed my mental picture of the future.

The AI Revolution: Road to Superintelligence – Why any aliens that do visit us are likely to be artificial, not biological. We may not be the king of our castle for very much longer…

Elon Musk: The World's Raddest Man – Why Musk is so rad and what happened when I met him.

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Sources:

PNAS: Prevalence of Earth-size planets orbiting Sun-like stars
SETI: The Drake Equation
NASA: Workshop Report on the Future of Intelligence In The Cosmos
Keith Wiley: The Fermi Paradox, Self-Replicating Probes, and the Interstellar Transportation Bandwidth
NCBI: Astrobiological phase transition: towards resolution of Fermi's paradox
André Kukla: Extraterrestrials: A Philosophical Perspective
Nick Bostrom: Where Are They?
Science Direct: Galactic gradients, postbiological evolution and the apparent failure of SETI
Nature: Simulations back up theory that Universe is a hologram
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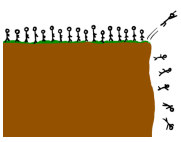

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The notion that the jump from prokaryotes to eukaryotes is common is ridiculous. Sure it happened 46 times but it took 2 billion years. We estimate that there are a few trillion prokaryotes on earth and they can divide in as fast as 20 minutes. Imagine how many evolutionary cycles that is, trillion of individuals with lifespans of 20 minutes over 2 billion years. The sheer amount of times that a eukaryote could've formed is astronomical yet it only happened 46 times.

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Interesting, thanks for pointing that out.

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1,005 comments so maybe this is a re-run comment, but: I didn't see any mention of the possibility of intelligent design. If some of the theories in this (awesome) article are plausible, so is ID.

7 • Reply • Share ›

Cyris Sargon ➚ dittoheadadt • 8 hours ago

ID is not a scientific theory. It is a religious idea put into a pseudo-scientific terms, at best, thus it doesn't belong in this article. No disrespect meant, but continue your thinking and investigations and I wish you good luck in your search for knowledge and wisdom.

• Reply • Share ›

dittoheadadt ➚ Cyris Sargon • 7 hours ago

No disrespect taken. :-)

First, I didn't call ID a "scientific theory." Just a theory. (Maybe there are, maybe there aren't, scientific elements to it. I'm not learned enough to weigh in on that question.)

Second, some of this WBW column itself stretches the bounds of "science." To wit:

"As many stars as there are in our galaxy (100 – 400 billion), there are roughly an equal number of galaxies in the observable universe—so for every star in the colossal Milky Way, there's a whole galaxy out there. All together, that comes out to the typically quoted range of between 10.22 and 10.24 total stars, which means that for every grain of sand on every beach on Earth, there are 10,000 stars out there.

The science world isn't in total agreement about what percentage of those stars are "sun-like" (similar in size, temperature, and luminosity)—opinions typically range from 5% to 20%. Going with the most conservative side of that (5%), and the lower end for the number of total stars (1022), gives us 500 quintillion, or 500 billion billion sun-like stars."

"100-400 billion" is a guess, not science. "Roughly an equal number" is a guess, not science. "Opinions typically range from 5% to 20%" is a guess, not science. "Going with the most conservative side" is a guess, not science.

So if this is less-than-a-purely scientific analysis, it stands to reason that other theories or possibilities deserve mention, if not some scrutiny. IMO.

• Reply • Share ›

Mike McCarthy • 18 days ago

https://arxiv.org/pdf/1806....

Recent paper that dopes out why the paradox isn't likely all that paradoxical, if you incorporate our actual uncertainty about each factor of the Drake equation (star formation rate, probability of a habitable planet, probability of life development, etc) vice applying an estimated point value to each factor.

TLDR: "When we take account of realistic uncertainty, replacing point estimates by probability distributions that reflect current scientific understanding,... we find a substantial probability that we are alone in our galaxy, and perhaps even in our observable universe (53%–99.6% and 39%–85% respectively). 'Where are they?' — probably extremely far away, and quite possibly beyond the cosmological horizon and forever unreachable."

2 • Reply • Share ›

Cyris Sargon ➚ Mike McCarthy • 8 hours ago

Wow, dated June 2018! And Eric Drexler (on of my favorite authors) was involved. Thanks for sharing!!!

• Reply • Share ›

Andre • a month ago

1000th comment.

4 ^ | v • Reply • Share ›

EL • a month ago

Great read!

1 ^ | v • Reply • Share ›

tshoo • a month ago

Maybe, intelligence is not a sustainable evolutionary advantage and we will be extinct soon. Maybe, most intelligent alien life does not last long enough to be able to intersect with other intelligent life.

1 ^ | v • Reply • Share ›

Doug Zembiec • 2 months ago

The simplest explanation is usually the most plausible. The most advanced civilisations have died out. Secondly, the Universe is massive. Imagine earth as an ant in Florida. The writer is wondering why a bee in Russia doesn't know about the ant. Yes there are billions of ants and billions of Bees but neither make a difference to each others lives because as you reach the pinnicale of the evolutionary tree without further evolution and change a species will die out. In other words because humans have protected themselves from their environment they have growth week genetically and eventually will die out

3 ^ | v • Reply • Share ›

@throwsknives • 2 months ago

One obvious factor no one ever seems to consider is the immensity of time. When we calculate the number of potential planets that could harbor intelligent life, consider that such life probably won't coexist within the same exact tiny sliver of time. Earth has had sentient life for just 1/30,000th of its existence, so the chance of another civilization finding Earth before we existed or after we are gone is much higher than the chance of finding us while we are here. Imagine 100 colonies of bacteria with two-week lifespans that could evolve, live and die during a 1,000-year span. The chances are high that none of the colonies would have any overlapping existence. But let's say two of them shared the same exact two-week window on the same continent. Then, one of the colonies, without knowing anything about the existence of the other colony, travels thousands of miles to find it. How likely is that? Another analogy: Imagine you are driving across the US on a two-week trip, looking for 10 particular people who will each be standing at a random location along your route for just five minutes - but you don't know where any of them will be, or when they will show up. What's the likelihood you will find any of them? Chances are, they would show up after you left or before you arrived, but not at the exact same time as you. That's what we're up against.

13 ^ | v • Reply • Share ›

> **Patrick** ↗ @throwsknives • 2 months ago
>
> Yes, this is a synchronicity issue which I've pondered, and wondered why no one else is bringing it up. Billions of planets with life have problably come and went, Finding a few that is synchronous with ours on the time line, well, has anyone done that calculation?
>
> 3 ^ | v • Reply • Share ›
>
> > **Martin Bardaro** ↗ Patrick • a month ago
> >
> > Because the universe is too young (sounds as a joke but it is true), think about, when the universe starts (around 14 billion years), it took´s almost half billion for the first stars start forming, at that time there was only simple hydrogen atoms (most of the astrophysicist think´s that), so the star start the fusion process (convert first all his H2 onto Helium) and that took´s several billion years to do, after all the H2 is converted to He, the star start to fusion the He, into something else, I don´t remember what, and so on, until Fe (iron), that´s most of the stars can fusion, after that the star explode and with the forces of that explosion creates more heavy elements, all that took´s a few more billion years, so if the universe has nearly 14b, and the earth has 4,5b, and we can assume that stars like sun last before explode 8b. do the math, and think that life starts as primitive cells when the earth have 1,5 - 2 billion years.
> > Of course that could happen other intelligence came before us, but, i think that any intelligence which can reach a type II will take a lot.
> > that´s what I think, but maybe (probably) I´m totally wrong.
> > so, live long and prosper :)
> >
> > 3 ^ | v • Reply • Share ›

David • 2 months ago

^5 to CatIS, Saturn Run is a fabulous read and highly recommended. Very imaginative. I don't think we'll be that far along in 50 years, but got to start somewhere. Congrats to Sandford and Ctein for their work.

It's pretty clear when you study the rare earth hypothesis and subscribe to the science involved in evolution that intelligent spacefaring life is extremely rare and requires an incredibly lengthy set of favorable circumstances to occur to produce intelligent life forms. I have no doubt that we will find that life is probably ubiquitous throughout the cosmos, but Level I, II, and III life to be more than extremely rare.

Most highly evolved life forms will not last long enough to colonize their own solar systems, much less their portions of the home galaxy. There are too many great filters at each stage of evolution to negotiate, certainly AI will be our next one. We are doing all of the right things in terms of SETI searches, finding planetary systems and will eventually find a habitable planet within our local area within 3-5 light years that we'll be able to send robotic probes to. I disagree with the overly optimistic numbers generated in the

dialogue of the blog, I think it more likely that there are no more than 1-5 Level I civilizations in the Milky Way galaxy, and probably no Level II civilizations. We have been listening and scanning for such a short period of time, it will be several centuries before we can expect to detect the presence of another Level I or less civilization. But we should by all means keep listening and looking, the prize is worth the risk, and after all, it is what humans do.

It is with great hope that I know we have a chance to become the first Level I civilization in our quadrant of the galaxy, and that is very exciting. Our limitation is our social maturity and to make sure our technological progress is not overwhelmed by our immature masses that spurn all attempts at becoming a spacefaring civilization because we have problems here on earth to take care of first.

It is refreshing to read WBW and the comments of deep thinkers, I hope we can have more discussions of these important topics in the near future

4 ^ | v • Reply • Share ›

Jack Reeve • 2 months ago

Oh, and on the subject of the Great filter, I think it's right in front of us. It's AI, and perhaps AI, once advanced, simply creates a reality to reside within that is utterly unknowable to us. I mean if you can't fathom where AI will be in 2075, then imagine it's unfathomability another century hence. Then ponder that at 200,000,000 years hence. Timmy's right; we're barely even viruses before such a presence.

2 ^ | v • Reply • Share ›

Jack Reeve • 2 months ago

Hi All, to me it's easy. I grasp that any civilization beyond ours is long ago electronic/digital, and is therefore unimaginably advanced. I feel it is silly to ponder them as cellular or biological. If you put them at the scale of manufacturing universes, then to me that's sort of the level I see them on. Interestingly there's a little masterpiece of a book from 1969 called MACROSCOPE. It grasps the notion of unimaginably advanced civilizations better than anything I've ever read or seen. "Scope" it out and you'll see what I mean.

2 ^ | v • Reply • Share ›

CatIS • 2 months ago

Nice piece - read it twice now. I didn't scan ALL of the comments, but a lot. Here's a new explanation - you can find it in the novel Saturn Run by John Sandford - and it's a fine tale also.
We humans finally stumble on a refueling station for all space faring civilizations - it's located near Saturn. We get there, and there is a resident AI that runs the place. The AI is open to discussion, and trading. One of the questions the humans ask is "What kinds of inter species relationships have been established in the galaxy." The answer - NONE. It is too damned dangerous. Rarely do two different species ever arrive at a common framework of understanding where they can actually interact with each other. The chance for misunderstanding and violence is just way too high - so NO ONE ever tries to interact with another species, except through these AI portals. It makes some sense - just look at the problems we have here on this planet with only ONE intelligent species in a variety of cultures. Imagine a species with a totally different set of emotions, ideas, rules and assumptions.

The book has a bunch of other interesting ideas. For example, this is a trading station - what did we bring to trade? Knowledge and science and the like are NOT free - you need to deliver something of value. What does a tiny ship sent from Earth to Venus carry that is worth anything in interstellar trade? I'll let you guess until you read the book.

6 ^ | v • Reply • Share ›

Clef • 3 months ago

This is some trash, some of it actually makes sense, but others...wow, you might need to go back to class

^ | v • Reply • Share ›

NicerThanClef ➚ Clef • 17 days ago

The point was literally to lay out all of the different possible explanations, whether they made sense to everyone or not. The author, at the very beginning, leads with the fact that scientists hotly debate these possibilities amongst themselves.

If you some of these ideas resonated with you while others abhorred you, then you are simply proving that point.

Don't be an asshole about it.

1 ^ | v • Reply • Share ›

Scott Skinger ➚ Clef • 3 months ago

Your opinion "might" be more respected if you shared some facts and started a conversation rather than just slinging mud.

25 ^ | v • Reply • Share ›

Jamie White • 3 months ago

This really is an incredible article and was the one that got me hooked on wait but why. I come back to this article all the time. Amazing work

6 ^ | v • Reply • Share ›

Jack • 3 months ago

"Possibility 7) We are receiving contact from other intelligent life, but the government is hiding it. The more I learn about the topic, the more this seems like an idiotic theory, but I had to mention it because it's talked about so much."

Why? People always opt out of this because they don't want to look stupid by associating with the UFO nuts. But never a real good answer is given. It's easier to go alongside the masses and "smart" people than challenge all that, get laughed at, and potentially proven wrong.

"Possibility 9) Higher civilizations are here, all around us. But we're too primitive to perceive them. Michio Kaku sums it up like this:"

Disagree with this analogy. The difference between a human and ant is that an ant really can't perceive or comprehend much. We could devolve our actions to that of an ant, crawl around and stuff, and the ant still would not understand much. On the other hand, any super-intelligent being that isn't somehow constrained from engaging with us entirely, should be able to enact some "primitive" actions in order for us to at least recognize its existence.

1 • Reply • Share ›

Alasdair Shepherd ➚ Jack • a month ago

Possibility 7 is generally regarded as "idiotic" because humans just aren't that good at keeping secrets. All real-world conspiracies fall apart eventually (except maybe for very small groups keeping a single secret and eventually taking it to their graves, like a group of train robbers or something). It's only in the minds of conspiracy theorists that "The Government" has the level of organisation and power required for some Men In Black-esque agency to successfully keep a lid on something this astoundingly world-shaking.

In reality, governments are not monolithic entities controlling the masses. They're generally a massive hodge-podge of dozens (potentially hundreds) of little departments and committees, each one made up of many, many human beings. It only takes one Edward Snowden. I assume all conspiracy theories are nonsense until someone actually provides proof. And these days there are safe havens for whistleblowers and their information. But still no proof except the stories.

People used to claim to have seen vampires, witches, eldritch apparitions, and other demonic entities that prey on humans, and I put stories of little green men (or more seriously, the Greys) abducting people and probing them in the same category. Do I think there is intelligent non-human life in the universe? Of course. As the article states, the universe is far too unimaginably vast for us to truly be the only ones. Do I think they've come all the way here, just to make contact with a tiny number of

see more

3 • Reply • Share ›

Mark C ➚ Alasdair Shepherd • 25 days ago

An ant coming across a superhighway would notice something is different. The ground is very flat and empty. But it wouldn't understand why. If it even had thoughts, it might just think it was part of the natural world, which it also doesn't understand much of.
For example, our galaxy is full of stars. Outside of the galaxy spacetime is fairly 'flat' and empty. It just looks flat and empty of stars. To us it just looks like part of the natural world; the way things are, based on our (limited) understanding of how the universe works (the known laws of physics, gravity/general relativity etc).
I'm not suggesting that in this specific case the space between galaxies is empty because aliens made it so, just trying to use the ants and highway analogy to show how much like ants we might be. The truth may be far stranger, and we may not actually be able to comprehend it.

2 • Reply • Share ›

@throwsknives ➚ Jack • 2 months ago

For the past decade, about half the population of Earth has carried high-resolution video and photographic devices in their pockets every waking hour of the day, most of them connected to a dozen or more global communication networks. And yet, nothing to suggest aliens are among us

4 • Reply • Share ›

Jack ➚ @throwsknives • 3 days ago

This is false. There are plenty of "UFO evidence"; have you seen any or all of it? No, you ignore it because you assume it must be fake from the start. Also, any alien capable of FTL or above would probably have technology to get around ever being seen if they didn't want to. They could also be interdimensional beings for all we know, etc.

1 • Reply • Share ›

Lauk N • 5 months ago

I know many avoid pessimism as a plague because humans have an awful the of the fear of death in the end of the day. We are a defecating, irrational species petrified of fear of not existing after all. But what if Great Filter is maybe voluntary self-destruction? Once a species reaches a threeshold of rationality it realizes how pointless is it's own existence, and recognizes and dissects it's own dumb emotions as nothing more than chemical reactions in a wrinkly brain. Once one realizes that our emotions, feelings are nothing more than biochemical illusions that evolved to propagate genes, a rational species exhausts itself. What

about awe, love, curiosity, hope.? Once one conquer the non-scientific behaviours that motivates science? As illusions? The absence of value of life? The lack of purpose? The absence of a rational reason to prefer life over death?
It's simply the end. Ultra-rationality leads to nihilism, to self-destruction. It's probably the reason.

Other thing too? Maybe a compassionate species would recognize the massive moral error that involves bringing an innocent child in a world of intense, abhorrent suffering like ours would implement antinatalism. They must had recognized that sentience is a curse, a malignancy that should be wiped from a planet. In sh.itty planets like ours we still allow the birth of sacrifical lambs to allow the purpose of the continuation of a stupid species so it finally achieves "progress".. Maybe it will change though.. Only suffering matters in the universe and life is a disgrace that should never had existed.

5 ^ | v • Reply • Share ›

René ➚ Lauk N • 2 months ago

There's no reason to be so pessimistic; just look around, there are all those who have discovered the Christ' Holy Spirit in their heart. They're all around doing good in the world-they're the future of the human race; but don't confuse them with the multitude of charlatan crawling the earth. Peace ✌

1 ^ | v • Reply • Share ›

Gils Reynard ➚ Lauk N • 3 months ago

"Where man is not, nature is barren."

^ | v • Reply • Share ›

Bruno Sanchez • 5 months ago

...and now, 4 years later, this is still the definitive article about the Fermi Paradox! Amazing work, Tim! Everytime someone try to mention something on the Great Filter, Drake equation or anything else related I always send this link.

6 ^ | v • Reply • Share ›

Roger Fenner • 5 months ago

Occam's Razor

2 ^ | v • Reply • Share ›

Jack ➚ Roger Fenner • 3 months ago

and which solution is most likely oh wise one

3 ^ | v • Reply • Share ›

Scarlet E. • 5 months ago

Where did these numbers came from? Any argument that they are even remotely close to truth? 1% for this, 22% for that, some of these looks exaggerated and one could argue, especially this 1% for advanced life forms, that can be intelligent enough to develop certain level of technology and allow us to notice them... 1% sounds greatly too big for me. Can anyone elaborate?

And if these should be drastically reduced, then maybe estimation above is wrong and should be few orders of magnitude lower than 100,000? If so, we don't even need to be much of unlucky with our "neighbors", but even this could be understandable in terms of such vast universe...

Also, remember that it took few billions of years for life on Earth to evolve
and Milky Way isn't really that old, and most of stars is estimated to
form between 8-12 billions years ago.
What if what took, say, 4 billion years for Earth, will require like 6-8 billion years on some other planet?

Maybe there's no paradox at all? There can be many planets with basic life forms, that are below our level of evolution, and it's okay. One of them luckily emerged (maybe more will follow in future) and that's why they (we) can observe surroundings, but there's not much to see yet. .. And that's it.

So, are there any concrete arguments that there is some "paradox" at all?

1 ^ | v • Reply • Share ›

Mike McCarthy ➚ Scarlet E. • 18 days ago

Scarlet,

https://arxiv.org/pdf/1806....

Paper that expounds on your ideas a bit. Suggests that there likely isn't a paradox if you update the estimates for each factor with recent guesses at each factor's range of probability/uncertainty.

1 ^ | v • Reply • Share ›

Samsquanch66 ➚ Scarlet E. • 5 months ago

5 • Reply • Share ›

Scarlet E. ➚ Samsquanch66 • 5 months ago

Thanks for the link!

• Reply • Share ›

Martin Morano • 5 months ago

Donald Drake reduce it to an equation, thousgh even admitted the quantities were guesses or attempts that were not based on knowledge or experience. Intelligent life may be even rarer. Many technically advanced aliens there may or may not be, very few will find it worthwhile to go traveling. If Earth isn't uniquee (and he could see no reason we are) then alienss ought to exist on at least some worlds. The paradox is why aren't they here?. What do you think I see as a problem which was already discussed in the premise? The absence does rule some things out though.We can rule out those aliens that satisfy the following 2 conditions: a) They are capable of revealing unmistakable evidence of their existence to us. b) They wish to do a).
Let us do a proof by contradiction.
a1) We do not have any unmistakable evidence of the existence of aliens.
If aliens that satisfy conditions a) and b) existed, by condition b), they would perform a). If they performed a), we would have unmistakable evidence of their existence. This contradicts a1).
Therefore, aliens that satisfy conditions a) and b) do not exist. The absence of evidencne is evidence of some aliens' absence.

• Reply • Share ›

@throwsknives ➚ Martin Morano • 2 months ago

The assumption is that intelligent must surely coexist in the same exact tiny sliver to time. The great filter may simply be existing for hundreds of millions of years. Sentient life may pass like trains in the night, separated by trillions of miles and millions of years. Sentient life may have existed in the past 14 billion years and may again in the future (after all, the universe has a lifespan of 100 trilion years), but why do we assume that another civilizarion must necessarily evolve in the exact same incredibly brief blip of time we occupy? The Drake Equation doesn't appear to consider the immensity of time and the fleetingness of life.
https://en.m.wikipedia.org/...

1 • Reply • Share ›

Amethyst Amulet • 6 months ago

Well, it could be that we haven't got minds creative enough to think of all the possibilities. For example, these discussions don't entertain the idea that the most common intelligent life may be made of dark matter. We as yet haven't found an easy way to interact with this stuff even though it constitutes 85% of all matter in the universe. We simply don't have any method to communicate with civilisations build from this stuff. First we need to develope detectors. Then we can investgate what this stuff is or isn't.

Or it might be that normal matter eventually evolves into dark matter and that is why there is so little normal matter and so much dark matter. Stars use fusion to generate energy but also create enormous amounts of neutrinos in the process. Maybe neutrinos somehow turn into dark matter. We can only hope that life exists within the dark matter realm in that case because if it doesn't we are doomed. If it does exist we are still doomed because normal matter would be disappearing in that case.

These are highly speculative thoughts. The truth is we just don't know enough. We need to build those detectors before we spend all our resources flying somewhere that ends up being a dead end. Finding SETI thumbprints or not isn't a success or failure at this stage. Searching, thinking, and observing while maintaining patience is the the key. We will know when we finally understand the cosmos. We have to remember we have at least 3 billion years to find the answer if we look after our resources.

2 • Reply • Share ›

Andy ➚ Amethyst Amulet • 5 months ago

Come on! Tim gave a hint in the article, but you should know already that the most intelligent lifeforms live in a virtual reality/universe. Take me for example!

1 • Reply • Share ›

Randy Compton • 6 months ago

I'm confused if an alien race started broadcasting radio signals into space around the same time as we did and they were thousands of light years away wouldn't we not have even had time to find them yet if it's taken millions of years for the light we see from stars to reach how do we detect radio signals faster

millions of years for the light we see from stars to reach how do we detect radio signals faster

Reply • Share ›

finny21 ➚ Randy Compton • 6 months ago

Our galaxy is around 100,000 light years across, so it would take 100,000 years for a radio signal from the opposite side to reach us. Even then, obviously, it would have to be a strong or directed signal from that distance. SETI enthusiasts often neglect to mention how powerful the signals have to be. I wonder if the most powerful omnidirectional radio broadcast in human history could be detected at the nearest star to our sun, with the most sensitive radio telescope ever created. Probably not.

The Andromeda galaxy is 2.5 million lights years away.

3 Reply • Share ›

gatorallin • 6 months ago

One more great reason why life on Earth was able to get started and then continue for billions of years. What if exactly how and why we have plate tectonics is more important that we thought.. and more rare than we thought? https://cosmosmagazine.com/...

14 Reply • Share ›

Robert s • 6 months ago

These discussions seem to overlook time. Anatomically modern humans have been around for about 200,000 years. Suppose we survive war, climate change, meteorites and pandemics for another 200,000. The earth has been around for over 4 billion years. If it's timeline were a mile long, we would take up six inches. What are the odds that the technological part of another planet's six inches aligns with ours. (Wavelength travel times cancel out.) So, there is/was/will be life out there, just not the same time as us.

8 Reply • Share ›

@throwsknives ➚ Robert s • 2 months ago

Yes! Someone else has considered this!

Reply • Share ›

Bob Fuller • 6 months ago

Where is everybody? Wiped out by gamma ray bursts

4 Reply • Share ›

@throwsknives ➚ Bob Fuller • 2 months ago

Either they were already here, or don't exist yet. Humans simply assume that if there's other intelligent life, it must have to exist at the same time as us. There's the distant past, the distant future and the incredibly short present. It's entirely possible that life is so rare, no intelligent life ever exists on more than one planet at the same time.

Reply • Share ›

Deepdark ➚ @throwsknives • a month ago

I think the Great Filter hypothesis considers time, if there was ever a intelligent life in the past in our galaxy, they:
a) would still exists to date and would have colonized the entire galaxy;
b) they were wiped by a Great Filter event that is still upcoming to us.

Reply • Share ›

Val • 6 months ago

I think if you can imagine it. It can and is true, possibly in other realities. I believe we are infinite possibility. Quantum Physics pretty much has proven that nothing is impossible. I do believe our potential is being suppressed purposely so we don't advance as a race.. Those who are suppressing us are the ones who control all government and know the ancient human races (prehistory) sacred practices, technology and ancient knowledge. Practicing, applying and building on this knowledge to further themselves while keeping us in the dark. But why? Is the potential we are capable of, a powerful threat? Are they aliens? Nothing is too far fetched. Ever. To dismiss is to set limitations and stunts the learning process.

3 Reply • Share ›

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Stephen Weng

I think the answer is obvious. Human technology is just not up to the task of detecting anything in space. I'm sure this is quite obvious, but let me just state the fact that humanity is NOT even an interplanetary civilization. Space travel isn't a fundamental and important part of our society yet. My position on Fermi Paradox: the Universe exploded into existence roughly 13.8 years ago...reionization...first stars...galaxies...Universe today. There are a few hundreds of billions of stars in our Galaxy alone and there are even more galaxies. No matter how you look at it the Galaxy has surely... See More

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Hafeezur Rehman

Our knowledge, experience and our thinking shows that we are stil in the begining . Unless we get more knowledge, more experince and more enriched thinking....we can not be certain where in time we are.

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Jamie Brindle

Another very interesting and enjoyably-written article 🙂. I have always felt that it seems a bit crazy to assume that we know what 'advanced' life would be like, that we could find traces of it by listening to radiation. Advanced life could be something totally different from what we are expecting, something unbelievably strange and bizarre to us. Perhaps the Universe is replete with advanced civilisations that exist as patterns of replicating energy within stars (there's an old Arthur C Clarke short story with an idea like this, and I have since seen similar concepts in other sci-fi novel... See More

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Aniruddha Watve

Can it be like humans are the first and have to start interspace travel and inhabit other planets is it our destiny or something is there watching us wiping clean civilization

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Benjamin Gunnells

none of the estimates of intelligent life are based on observations. In fact no planet like earth, or a solar system remotely set up the way our solar system is set up, has ever been observed! scientists are making wild guesses based on literally nothing...we have not found a single planet confirmed to be capable of supporting any kind of life, even bacterial yet they have created a "formula" for the number of habitable planets in the galaxy? absurd! I'm sure there is life, and intelligent life at that, out there but there is ZERO evidence to support the current estimates of habitable worl... See More

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Eric Augustinowicz

Even if we find other civilizations, maybe we pick up a radio signal, and they're all real nice to us, it doesn't rule out the idea that there's a preditor species in the universe that's intent on killing other intelligent civilizations. That's pretty unethical! But the fact that it could be true means that it IS true. So we must protect ourselves. The best course of action now is for us to develop civilization-ending and civilization-enslaving technology ourselves, and start locating civilizations in the universe and killing and enslaving them. We must become the preditor.

Perhaps we're the... See More

Like · Reply · 36w

Ken Wamalika

I believe the answer is group 2: number 8. super-intelligent civilizations exist in a tightly-regulated universe, and our Earth is treated like part of a vast and protected national park, with a strict “Look but don’t touch” rule, until we have attained to a certain level.

Like · Reply · 40w

James Berger

There also is the Easter egg hypothesis, that they are here, but only covertly. But they do still leave tantalizing clues to their presence (I.e., the 'Easter eggs'). I actually have this theory I have been sharing with others for close to

20 years now. Consider so-called coincidences. Some of them are explainable. But some are rather striking, like the Tecumseh Curse. Seven presidents between Jefferson and Reagan elected in a year ending in zero died in office. All seven. Then there is the 'miracle' at Fatima, Portugal. And so-called ghost phenomenon. Don't laugh. Carl Sagan once said we might be mistaking ET's for ghosts. I wonder if that is what he meant. On the other hand, I could be wrong. And it's only a theory. I offer no further proof. But it is no more weird than any of the other theories...

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Roger Kelley

One point could be: We have other intelligent species here on Earth now, we just don't call them that. Think about Toothed Whales, we can't understand their language, but we do know they have a well-developed, and complex language, or more likely, a set of Whale languages. Possibly more than a few for each separate population of each species of Whales. Think about why any Whales did not develop any type of technological civilization. That's easy, no hands to make tools so they can manipulate objects, and eventually make devices to make their lives easier. Maybe the combination of having hands, with a mind that can invent tools made of materials that can last long enough to be used by more than one individual, more than one generation, is a common filter.

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Warren D Ffolkes

I really want you to read planet earth by Chris Thomas if you incorporated the metaphysical an spiritual aspect into your writings it would be awesome.

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Бобс Картофи

Or we're gonna destroy ourselves in 10 hours in a nuklear war and we'll never fucking know
The end

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