

In the Great Silence there is Great Hope

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The idea of life on Mars has been with us for nearly 300 years, ever since early astronomers saw what they believed to be polar ice caps through their primitive telescopes. Since then, space probes have indeed confirmed that the red planet has water and future missions might tell us if Mars contains any traces of life, whether extinct or still active. Such a discovery would be of tremendous scientific significance: the first time that any signs of extraterrestrial life have ever been detected. Many people would also find it heartening to learn that we're not entirely alone in this vast cold cosmos.

Well, I hope that our probes will discover *nothing*. It would be great news to find that Mars is a completely sterile planet. Dead rocks and lifeless sands would lift my spirit.

On the other hand, if we discovered traces of some simple extinct life form: a bacterium, some algae, it would be bad news. If we found fossils of something even more advanced – like a trilobite or even the skeleton of a small mammal, it would be horrible news. The more complex the life we found, the more depressing the news. Scientifically interesting yes, but dire news for the future of the human race.

Let me explain.

It's a fact that, UFO-believers notwithstanding, there's been no objective evidence for the existence of any extraterrestrial intelligent civilization. They visit us in books and films and in rumors on internet chatrooms. But to date, we've have not received any alien visitors, nor have our radio telescopes detected their signals. As far as we can determine, the night sky is empty and silent. Ok, so what's the significance of this?

We know that the universe contains many stars – some 100 billion of them in our galaxy alone, and the observable universe contains billions of galaxies. Thanks to recent astronomical discoveries we now know that it's common for these stars to have planets, including Earth-like planets. Many of these solar systems are much older than our own. Yet, so far, no extraterrestrial civilization has showed up in our neighborhood. You start with billions and billions of potential germination points for life, and you end up with a sum total of *zero* alien civilizations that developed technologically to the point where they become manifest to us Earthly observers. So what's stopping them?

There must be some kind of barrier that prevents the rise of intelligent, self-aware, technologically advanced, space-colonizing civilizations. We can conceptualize this barrier as a "Great Filter" – in essence, one or more highly improbable steps along the path that starts with the creation of a planet and ends with a race capable of colonizing the galaxy in spacecraft.

Somewhere between those two points, the Great Filter operates, and it must be powerful enough that even with all the billion of possible starting worlds on which life might evolve – all those rolls of the cosmic dice, one ends up with nothing: no aliens, no spacecraft, no signals, at least not in our neck of the woods.

The important question for us however, is just where might this Great Filter, be located? Is it behind us, in our distant past or somewhere ahead of us in the millennia or decades to come?

Consider first the possibility that the filter is in our past, somewhere between the creation of our planet and emergence of digital technology. We tend to take it for granted that the evolution of life was straightforward. Lengthy, yes, complex, sure, but ultimately inevitable because, well, here we are. But perhaps it's extremely improbable that on any Earth-like planet even simple self replicating organisms should emerge. Perhaps that very first step could be the Great Filter in which almost all planets get stuck. Or perhaps it comes later, during the transition from the most basic life form into something more complex? For example, it took 1.8 billion years for life on Earth to evolve from prokaryotes, the most basic organism, into

eukaryotes – still very simple but with the addition of a membrane-enclosed cell nucleus. All that time in which apparently nothing much happened suggests that some extraordinary improbable coincidence, some bit of amazing luck, might have been required in order for the right set of mutations to occur to enable something simple to become something just a little bit more complex. This step is a good candidate for a Great Filter. Others include the rise of multi-cellular organisms or sexual reproduction. Each of these steps took a very long time, suggesting that they might have required a huge amount of evolutionary trial-and-error combined with a huge amount of luck to overcome some vast improbability.

So one possibility is that the Great Filter is behind us and if so, this also explains the absence of observable aliens. Why? Well, because if the rise of intelligent life is sufficiently improbable then it follows that we are likely the only such civilization in our galaxy or even in the entire observable universe.

Don't like the idea of such a desolate universe? Okay, so what about the possibility that the Great Filter is ahead of us, in our future? That would mean that there is some great improbability that will prevent humanity – and perhaps all technological civilizations – from traveling to other parts of the galaxy and making their presence known to others.

Throughout history great civilizations on Earth have imploded – the Roman Empire, the Mayan civilization that once flourished in Central America – but here we are hypothesizing a more drastic termination – the extinction of the intelligent species itself, or at least the permanent destruction of its potential for further development. But what have we got to fear? Nuclear War? Environmental disaster? A deadly superbug? We might recover from any of these, eventually. Only something that could cause an existential disaster may qualify as a Great Filter. The kind of collapse that merely *delays* the eventual emergence of a space-colonizing civilization by a few hundred or a few thousand years would not help explain why no such civilization has visited us from another planet. A thousand years may seem a long time, but in this context it's a sneeze. There are planets that are billions of years older than Earth. Any intelligent species on those planets would have had ample time to recover from repeated social or

ecological collapses. Even if they failed a thousand times before they succeeded, they could still have arrived here hundreds of millions of years ago.

Obviously, we must hope that the Great Filter is behind us rather than ahead of us. If the Great Filter is ahead of us, we have still to confront it. If it is true that almost all intelligent species go extinct before they master the technology for space colonization, then we must expect that our own species too will go extinct before reaching technological maturity, since we have no reason to think that we will be any luckier than most other species at our stage of development. If the Great Filter is ahead of us, we must relinquish all hope of ever colonizing the galaxy; and we must fear that our adventure will end soon, or at any rate that it will end prematurely.

Now what has all this got to do with finding life on Mars? Consider the implications of discovering that life had evolved independently on another planet in our solar system. That discovery would suggest that the emergence of life is not a very improbable event. If it happened independently *twice* here in our own back yard, it must have happened millions of times across the galaxy. This would mean that the Great Filter is less likely to occur in the early life of planets and is therefore more likely still to come. If we discovered some very simple life forms on Mars in its soil or under the ice at the polar caps, it would show that the Great Filter must exist somewhere after that period in evolution. If we then discovered a more advanced life form, such as some kind of multicellular organism, this again would be even worse news for us. And if we discovered the fossils of some very complex life forms, like a vertebrate mammal, we would have to conclude that the probability is overwhelming that the bulk of the Great Filter is ahead of us. Such a discovery would be a crushing blow.

Yet most people reading the about the discovery would be thrilled, not realizing that they were looking at the worst news ever displayed on the front page of a newspaper. They would not understand the implications of the finding. If the Great Filter is not behind us, it is ahead of us, meaning that the human species is doomed to fail ever to reach technological maturity.

So this is why I'm hoping that our space probes will discover dead rocks and lifeless sands on Mars, and also on Jupiter's moon Europa, and everywhere else our astronomers look. It would keep alive the hope for a great future for humanity...

[music break]

[*Change of tone*]

The great Italian-born physicist Enrico Fermi once asked some colleagues he was having lunch with the question: "Where are they?", referring to the absence of any signs of extraterrestrial intelligences. This absence puzzled him, and his question later became known as Fermi's paradox.

So far I have been focusing on the simplest and most straightforward answer to Fermi's paradox: we haven't seen any aliens because there aren't any around. Not the most thrilling repost, and perhaps for that reason people have busied themselves concocting more fanciful explanations.

One might speculate that the reason why we have not seen any extraterrestrial civilizations is not because there aren't any, but because they're invisible. Maybe there is a secret society of advanced civilizations that know about us but have decided not to contact us until we're mature enough to be admitted into their club. Perhaps they're observing us, like animals in a zoo. This is known as the "zoo hypothesis".

However, I don't think this is likely. On Earth, life has spread to every nook and cranny that can support it. Life goes wherever it can, and that includes the galaxy. So should any civilization reach the requisite stage of technological ability, it will most likely attempt to colonize space. Even if *some* advanced civilizations decided permanently to forego space colonization, this would only hand the initiative to some other more intrepid civilization. It takes only one match to start a fire, and it takes only one expansionist civilization to launch the colonization of the universe.

As for the *feasibility* of space colonization, even we humble humans can already identify technologies which would enable us spread into space, such as nanotechnology, artificial intelligence, and robotics. In fact our early space probes are still out there – Voyager 1 for example, now beyond our solar system. Relatively soon, it will become possible to send out probes capable of building other probes and turning material from comets or energy from stars into fuel. Imagine if one probe could replicate itself ten times and then each of those does the same – within a few centuries you could have billions of such probes on route to all parts of the galaxy.

If we could do it, so could any advanced race. So why haven't we seen one? By far the simplest – and in my opinion the likeliest – explanation is that there aren't any – at least not in our galaxy. And that means no advanced alien races either.

Some people object that it would be an amazing coincidence if Earth were the only planet in the galaxy on which intelligent life evolved. If it happened here – the one planet we have studied closely – surely one would expect it to have happened on a lot of other planets in the galaxy also, which we have not yet had the chance to examine?

This objection, however, overlooks an observation selection effect. If you think about it, whether intelligent life is common or rare, every observer is guaranteed to find themselves having originated from a planet where intelligent life did arise. Since only the successes give rise to observers who can wonder about their existence, it would be a mistake to regard our planet as a randomly selected sample from all planets.

If – as I hope is the case – we are the only intelligent species that has ever evolved in our galaxy, and perhaps in the entire observable universe, it does not follow that our survival is not in danger. Nothing in the above reasoning precludes the Great Filter from being located both behind us *and* ahead of us. It might both be extremely improbable that intelligent life should arise on any given planet, *and* very improbable that intelligent life, once evolved, should succeed in becoming advanced enough to colonize space.

But we would have some grounds for hope that all or most of the Great Filter is in our past if Mars is indeed found to be barren. In that case, we may have a significant chance – if we play our cards right – of one day growing into something almost unimaginably greater than we are today.

In this scenario, the entire history of humankind to date is a mere instant compared to the eons of history that lie still before us. All the triumphs and tribulations of the millions of peoples the have walked the Earth since the ancient civilization of Mesopotamia would be like mere birth pangs in the delivery process of a kind of life that hasn't really yet begun. Because surely it would be the height of naiveté to think that with the transformative technologies already in sight – genetics, nanotechnology and so on – and with millions of years to perfect and apply these technologies and others that we haven't yet conceived of, human nature and the human condition will remain unchanged for all future. Instead, if we survive and prosper, we will develop into some kind of posthuman existence.

Imagine the tremendous responsibility of those who find themselves present and called upon to midwife the conception of such a future.

And that is where we are, you and me.