Presumptuous Philosopher Proves Panspermia

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**Abstract**. The *presumptuous philosopher (PP)* thought experiment lends more credence to the hypothesis which postulates the existence of a larger number of observers than other hypothesis. The PP was suggested as a purely speculative endeavor. However, there is a class of real world observer-selection effects where it could be applied, and one of them is the possibility of *interstellar panspermia* (IP). There are two types of anthropic reasoning: SIA and SSA. SIA implies that my existence is an argument that larger *total* number of observers exists; SSA implies that I should find myself in a region with larger number of observers. However, as S. Armstrong showed, SIA can’t distinguish between different ways how larger number of observers appeared, so it can’t favor IP compared with other ways to get many observers. SSA application here is less controversial as it tells only about relation between regions size: e.g. I am more likely to live in a larger country than in a small one, conditioning that the total number of small countries is also small.

Anthropic considerations suggest that the universes in the multiverse with interstellar panspermia will have orders of magnitude more civilizations than universes without IP, and thus we are likely to be in such a universe. This is a strong counterargument against a variant of the *Rare Earth* hypothesis based on the difficulty of *abiogenesis*: even if abiogenesis is difficult, IP will disseminate life over billions of planets, meaning we are likely to find ourselves in a universe where IP has happened. This implies that there should be many planets with life in our galaxy, and renders the Fermi paradox even sharper. Either the Great Filter is ahead of us and there are high risks of anthropogenic extinction, or there are many alien civilizations nearby and of the same age as ours—which is itself a global catastrophic risk, as in that case the wave of alien colonization could arrive between 25-500 ky from now.

**Keywords**: panspermia – anthropics – presumptuous philosopher – Fermi paradox – self-indication assumption – existential risks

**Highlights**

* Anthropics implies that we are likely to find ourselves in the region of the universe with larger share of observers.
* The universes with interstellar panspermia have more observers and thus we are likely to be in such universe.
* In panspermia-universe abiogenesis is not a Great filter, and thus Later Filter is more probable.
* Alien civilizations, if they exist, could be in the Milky Way Galaxy and are approximately of our age, as we come from the same Eden.
* If there is no universal Great filter, alien colonization wave could arrive soon (around 25-500 ky years from now).

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# 1. Introduction

Serious arguments were recently presented in favor of the Rare Earth hypothesis stating that we are alone in the universe (Sandberg et al., 2017; Totani, 2020). However, such arguments do not take into account the possibility of *interstellar panspermia*, which postulates that if life appears once, it will be able to inseminate the whole Galaxy within a few billion years.

**Argument outline:** Imagine that there are two similar galaxies; in one, interstellar panspermia is possible, and in the other, it is not. Both galaxies began with just one planet with life. In the first galaxy, there will be 10 billion planets with life after a few billion years, while the second galaxy will still have just one. Now, you wake up one morning and ask yourself—which galaxy are you are more likely to find yourself in? There is a 10 000 000 000 to 1 chance that you will find yourself in the galaxy with panspermia, as there are 10 billion more habitable planets with life in that galaxy. This means that you are more likely to observe yourself in the parts of the universe where interstellar panspermia is actually happening. This makes the Fermi paradox even stronger: our Galaxy must be full of planets with life, and yet we still haven’t observed aliens.

Napier wrote that interstellar panspermia is actually possible and suggested a detailed mechanism (Napier, 2004). The mechanism of interstellar panspermia are analyzed in (Ginsburg et al., 2018).

Anthropics is a growing field used to make interesting predictions (Bostrom, 2013; Ćirković et al., 2010). Self-Indication Assumption was already used to predict the distribution of the civilizations in the multiverse: the civilization with later great filter are more often (Grace, 2010). Another example (besides panspermia) of the fine-tuning for more civilizations isLee Smolin’s *evo-devo fecund universes* (Smolin, 1992). In one interpretation of this theory, civilizations create artificial black holes, which in turn create universes with properties that support the formation of life (Crane, 2010).

The idea that SIA favors universes with higher density of observers was discussed by R. Neal (Neal, 2006) relative the theory that habitable planets exist only on specific distance from galactic center.

Olson used SIA to estimate the total number of expansionist civilizations in the observable universe: “In the present case, the strength of SIA manifests in a slightly different way. SIA does not blindly favor “more life” — it favors more life with exactly our anthropic information. Conditions that are too favorable for expansionistic life must be ruled out, because SIA favors conditions for us to appear at the present cosmic time, in an empty galaxy — too many expanding civilizations diminish the opportunity for that to occur” (Olson, 2020).

In this article, we will explore the necessary conditions for the numerical domination of observers in panspermia universes. Section 2 is devoted to the presumptuous philosopher thought experiment and the constraints on its applicability. Section 3 addresses the possibility of interstellar panspermia. Section 4 combines the results from two previous sections and applies anthropics to panspermia. Section 5 analyses possible counterarguments and transforms them into constraints on the applicability of this theory. In Section 6, we examine the consequences of interstellar panspermia for humanity.

# 2. Presumptuous philosopher thought experiment

## 2.1. As an illustration of the self-indication assumption

Bostrom suggested (Bostrom & Ćirković, 2003) the following *presumptuous philosopher* (PP) thought experiment:

It is the year 2100 and physicists have narrowed down the search for a theory of everything to only two remaining plausible candidate theories: T1 and T2 (using considerations from super-duper symmetry). According to T1 the world is very, very big but finite and there are a total of a trillion trillion observers in the cosmos. According to T2, the world is very, very, very big but finite and there are a trillion trillion trillion observers. The super-duper symmetry considerations are indifferent between these two theories. Physicists are preparing a simple experiment that will falsify one of the theories. Enter the presumptuous philosopher: “Hey guys, it is completely unnecessary for you to do the experiment, because I can already show you that T2 is about a trillion times more likely to be true than T1!”

This thought experiment was presented to illustrate the idea of the *Self-Indication Assumption (SIA)*—one of two main principles of anthropic reasoning. SIA requires a person to take his/her own existence as evidence that more observers exist. In fact, Bostrom analyzed the PP thought experiment as a counterargument to SIA. He thinks it should trigger a feeling of absurdity, as it provides a counterfactual ability to prove physical theories without experiment. However, proving panspermia is a practical example of such reasoning.

## 2.2. SIA and SSA merge in infinite universe

Classical SIA requires the existence of finite universe with finite but unknown number of observers, either trillions or trillions of trillions in PP thought experiment. But Tegmark showed that there are several reasons that the universe must be actually infinite. In the infinite universe, classical SIA doesn’t work as my existence is not evidence for anything: I will exist no matter if I am very unlikely or not. There will be always regions there even very improbable observers exist. SSA works as I am more likely to find myself in more probable regions where most observers are located. The reference class is not a problem as showed in the article “Meta-doomsday argument”, as for any type of question there is its own reference class: for example, I am randomly selected by *height* from all people, and also by *location* relative to equator.

However, here is assumed that my location and height are not correlated, but in reality, small correlation exists. To account for it, I actually should use full-non-indexical-conditioning, that is, I should take into account all my properties and calculate distribution of my copies through-out the multiverse. But if correlation is small, I could ignore it and treat each my property as independent random variable. In the case of the panspermia there are no known observable things connected with panspermia, so I can’t get much information about reality of panspermia from my other observables. Therefore, I regard p(panspermia) as a random variable: my exact or almost exact copies could live in worlds with or without panspermia. The small difference could be present, like a rate of meteor impact or intensity of cosmic rays, but as far as I don’t know it, or at least do not use it explicitly in writing this article, my copies are functionally the same and could be treated as equal in decision theoretical and anthropic sense (Yudkowsky & Soares, 2017).

In other words, Bostrom’s presumptuous philosopher thought experiment could be simplified by assuming that a multiverse does exist, and that it is full of different Hubble-volume-size universes with different properties, each with a different number of observers. Now the question is: “where we are in it?” In that case, the logic reduces to the *Self-Sampling Assumption (SSA)*: the line of reasoning there I am randomly selected from all actual extant observers in my reference class. If there is no multiverse, but just one our Hubble volume, then panspermia needs SIA for to be proved. In short, SIA collapses into SSA in an infinitely large universe. As there are significant arguments in favor of very large universe (chaotic inflation, string landscape), we could ignore philosophical disputes regarding which assumption (SSA or SIA) is correct, and reason as if SIA is true. A deeper discussion about applicability of SIA is presented in section 5.10.

## 2.3. Constraints on anthropic reasoning about the number of civilizations

There are three limitations for the anthropic reasoning when we apply it to compare the number of civilizations in different parts of multiverse.

1. *Multiverse must actually exist.* We assume that there are many Hubble-size volumes with slightly different laws of physics. These may be based on “string theory landscape” which suggests 10500 different vacua (Susskind, 2003). All these regions have the same ontological status of *actual existence* as our universe (so they are not merely *possible*).
2. *No infinities*. We assume that the multiverse is large but finite and that it does not have non-physical extremes. For example, there are no universes that are infinite in size and in which every atom is conscious. Otherwise, all observers would be in that universe.

In other words, there is no *anthropic monster* (analogue of the *utility monster –* a thought experiment in utilitarian philosophy, in which some being received much more utility from any unit of consumed resources (Nozick, 1974)), which attract almost the entire mass of observers. Two examples of anthropic monsters are the simulation argument (Bostrom, 2003; Turchin et al., 2019) and Boltzmann brains (Davenport & Olum, 2010; Turchin & Yampolskiy, 2019). We ignore the simulation argument that implies that most observers will be in simulations, because simulations—at first glance—are indifferent about simulating universes with or without panspermia, and all possible simulations cannot coordinate to lie in the same way about a random thing.

We also exclude the idea of infinite multiverse, as there could be formal difficulties in comparing the numbers of observers. But this requirement is not strict, as a way to compare infinite numbers of observers could be found—in much the same way as we can compare infinitely small numbers in calculus.

1. *Normal countable observers.* We count all minds as indistinguishable and equal, but numerically different. They are not exact copies of each other, but they use the same reasoning to come to the same conclusions. But they also must be different so we can count them.

We also assume that every mind has the same anthropic weight—that is, that the probability of finding oneself one of any of two randomly selected minds is 0.5. (The opposite situation is, for example, a probability of being a conscious observer in a pair comprising a human and a cat. I am much more likely to be a human than a cat, so in other words, a human being has much more anthropic weight than a cat). The anthropic weights of minds may depend on them being real or simulated, original or copies, whether or not they have qualia, how much energy they use for computation, and how complex they are. We do not know the solution to the anthropic weight problem, but we can assume that similar biological minds have equal weights, and that if an alien civilization produces biological minds, they will have the same anthropic weight as human minds. Further, we assume that most other civilizations (if there any), are similar to human civilization and consist of individual beings (not, e.g., thinking oceans or anthills), with anthropic weights that can be estimated.

# 3. The idea of interstellar panspermia

## 3.1. Interstellar panspermia

Small bacteria-size features have survived the reentry on Martian meteorites on Earth, which demonstrates the possibility of transfer of life from one planet to another via asteroid collisions and the debris they produce (McKay et al., 1996). Meter-size bodies do not overheat from inside during the atmospheric entry, but relatively slowly lose speed and not evaporate during the impact. Thus, life could appear on one planet, but move to another. This phenomenon is called panspermia (Kirschvink & Weiss, 2002). Indeed, recent observation of the interstellar comet *Oumuamua* (Do et al., 2018) shows the possibility of the interstellar exchange of matter, which suggests not only interplanetary but interstellar panspermia.

Lingam and Loeb wrote: “We find that ~400 interstellar objects of radius ~0.1 km could have struck the Earth prior to abiogenesis, while the corresponding number of km-sized objects is ~10. Hence, life could have been transferred to the Earth by means of lithopanspermia” (Lingam & Loeb, 2018). Thousands of interstellar comets could be caught by the gravitation of our solar system with the help of Jupiter. Such comets may then have been eroded by local impacts and create meteoritic showers on Earth, which will deliver life via impactors of the proper size. The larger original bodies could be warm enough (because of radioactive decay) to ensure the survival of life during the millions of years of the interstellar part of their journey. The largest bodies the solar system could capture could have a 60-km diameter. Such a long chain of events seems highly improbable, but we have already observed many of its elements, which suggests that our universe is adapted for the interstellar panspermia.

A shorter route is also possible: planetary debris could arrive directly within the solar system and impact Earth (Siraj & Loeb, 2019). An interstellar meteor has already been observed, identified as such by its high speed (but it was small and burned out completely).

It has been estimated that there are around 10 billion potentially habitable planets in our galaxy (Hsu et al., 2019). If at least one has developed life, *interstellar panspermia* of small organisms will inseminate many of them with life in a few billion years.

## 3.2. Difficulty of abiogenesis suggests Rare Earth

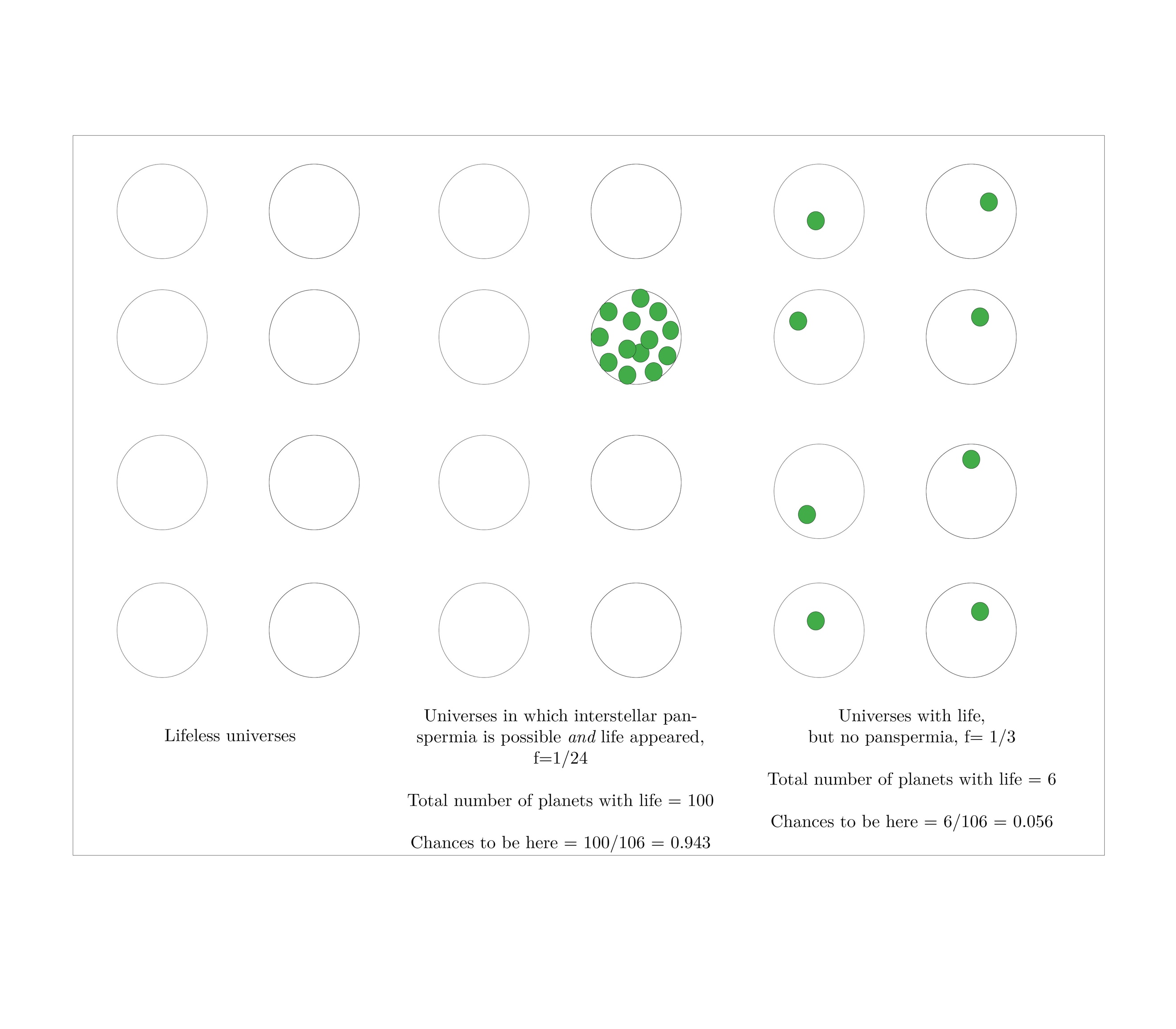
*Abiogenesis*—the appearance of the first living organism from dead matter—could be the main filter of the Fermi paradox. The current best idea about abiogenesis is an *RNA world*, where self-replicating strains of RNA work both as information carriers and enzymes and evolved to become more complex in the face of fierce competition. However, a first RNA capable of self-replication had to appear somehow. A recent estimate of the minimum length of self-replicating RNA is around 100 bases (Totani, 2020). Such a sequence could not evolve from shorter strains, but must have arisen from random combinations. Totani wrote that only 1 of 10100 solar-like stars systems with planets will generate such RNA via randomness to start the RNA-world of self-replicating RNA strands. Thus, he concludes that only 1 of 1080 of Hubble-volumes has life. Based on that, it seems likely the Rare Earth hypothesis is true and that we are alone in the observable universe. However, this line of reasoning does not consider the possibility of interstellar panspermia, which could disseminate life to many planets after appearing only once.

# 4. Share of universes with interstellar panspermia and the number of observers in them

## 4.1. Share of observers in panspermia universe

There are (presumably) many different universes in the multiverse and some may allow panspermia. Let’s call the visible Hubble volume of a universe where interstellar panspermia is physically possible and has a high chance of successes a *panspermia universe* (PU), and let’s assume that the number of potentially habitable planets in a galaxy is not affected by whether the universe supports panspermia. Then the density of planets with life in a PU is 10 billion times greater than such density in a non-panspermia universe, as each instance of life will colonize the whole galaxy (and maybe some nearby galaxies). This doesn’t mean that each planet will create a civilization and observers, but this proportion (the probability that the planet with life will eventually develop a civilization) does not depend, at first glance, on the existence of panspermia. However, it should be noted that asteroid impacts will occur more frequently, and stars appear closer to each other in universes with panspermia, thus increasing risks from supernovas; there are also effects of space colonization on civilization density, which will be discussed in Section 5.

The main question is the relation between the frequency of panspermia universes to those with just one planet with life (LU) within the whole multiverse. It is not easy to define *frequency of universes in the multiverse*, but here we assume that whole multiverse could be divided on bubbles with different physical laws, and each bubble contains finite number of “observable universes”, that is causally connected regions; our observable universe is just one of such regions. Different bubbles may have different speed of light or size, so they will contain different number of causally connected regions. What we are calculating here is the relation of causally-connected regions of some type to the total number of such regions across all bubbles; to escape infinities, this relation could be understand as a limit of the proportion for larger and larger regions of the multiverse.



If the panspermia universes frequency fpu in the multiverse is greater than the frequency of universes with just one habitable planet flu divided by the number of planets *m* that could become habitable if infested with life in the galaxy (we assume that *m* = 10 000 000 000), then we are more likely to be in a universe with panspermia. More generally, the chance of being in a panspermia universe is:

P(PU)= N(pu)/(N(pu)+N(lu) )= mfpu/( mfpu +flu)

And it is close to 1 is flu/fmu << m

Some universes may have no galaxies at all, or have much larger galaxies with a higher concentration of stars than others. Here, though, we consider only panspermia universes with galaxies. A galaxy, for our purposes, is a gravitationally connected group of stars between which an exchange of matter could happen. The Milky Way is such a galaxy, but it probably could also exchange matter with nearby dwarf galaxies, so they also should be included in the equation.

## 4.2. Two types of universes with panspermia

There are two ways how panspermia can increase the number of observers. In the first one, there is just one planet in a galaxy which could produce intelligent life, but abiogenesis is difficult, and thus panspermia is need to bring life to this planet from other parts of the Galaxy.

In the second case, if there are many habitable planets in the Galaxy, panspermia ensured that all of them are provided with life and most of them create civilizations.

In the first case, we live in the galaxy, in which there are a lot of instances of life, but most of it is microbial life on some underground water, and no complex biospheres exist. Thus, as a civilization we are still alone. In the second case, we live in the galaxy in which many civilizations like ours have appeared (but maybe gone extinct later).

The anthropic argument in favor of panspermia works in both cases. In the first case, it just makes *abiogenesis filter* less difficult and thus universes with such property are more frequent in the mutiverse. In the second case, it also increases the number of observers in each galaxy in which at least one instance of life appeared. But it requires many potentially habitable planets and lower level of space catastrophes for each planet. Space catastrophes could be a significant early filter which we can’t observer because of anthropic shadow (Ćirković et al., 2010; Turchin & Denkenberger, 2019a).

Anyway, the second type of panspermia likely to produce several orders of magnitude larger share of observers and thus is more likely to be our location. Is it real or not, depends on other early filters (not abiogenesis), like the appearing of eukaryotes, or (negative filter) lack of space catastrophes like asteroid impacts.

## 4.3. Incorrect argument that we should find ourselves in the universe with the highest density of observers without panspermia

Another similar argument, based on anthropics and self-indication assumption but arguing against the Rare Earth hypothesis, is presented by (Lanrian, 2019) and states that we should live in the universe with the *highest* *concentration* of civilizations, but this concentration is limited by the absence of observations of aliens (Fermi paradox). Based on this idea, he calculates around 100 civilizations for a Hubble volume, as they cannot yet see or reach each other.

However, we should not confuse the *density of observers* in the multiverse with the *total number* of observers of some type. Lanrian assumes that we should find ourselves in the region with the highest *spatial density* of observers. This is not true. For example, the highest density of people is in Hong Kong, but most people on Earth live in small towns (United Nations, 2018).

If we look at the distribution of objects in high dimensional functional space (like the fine-tuning of many parameters for universe habitability), the most objects will be not in the place that has received the best fine-tuning, but in the semi-fine-tuned region, which are less stable and have a lower concentration of observers. There is a tradeoff between the rareness of fine-tuning and the resulting increase of civilizational density: if the product of these factors is more than one, we are more likely to be in a hyperfine-tuned universe. For example, if panspermia gives a 10-billion-fold boost for the number of observers in a universe with life, but panspermia-capable universes are only 1 per trillion in all universes with life, the observers in them will not numerically dominate.

An example of such functional space is presented in the article “A Statistical Estimation of the Occurrence of Extraterrestrial Intelligence in the Milky Way Galaxy” (Cai et al., 2020) where the Sun occurred to be not in the most optimal place of age and distance form galactic center, but the total size of sub-optimal space is much larger than optimal.

# 5. Counterarguments

The are several counterarguments to the idea that we live in the universe with interstellar panspermia because of observation selection effects. We will try to answer these counterarguments or convert them into constraints or conditions here.

## 5.1. Objection 1: The additional fine-tuning for panspermia is so difficult that less than 1 out of 10 billion habitable universes will have panspermia

The possibility of panspermia requires *very fine* fine-tuning of the universe’s parameters, and these parameters are already fine-tuned to produce life and support observers (which at least requires planetary stability).

However, it may turn out that panspermia is a necessary condition for any civilization at all, as normal planets do not have time to support their evolution. Earth gave rise to life immediately after it cooled enough, which assumes either panspermia or easy abiogenesis. There are expected to be between 100 million and 1 billion years before the growing luminosity of the Sun will evaporate oceans on Earth, so if abiogenesis took longer here, life would not have had time to develop a civilization. The short window on Earth in which life could evolve into observers implies the need for interstellar panspermia.

## 5.2. Objection 2. The additional fine-tuning for panspermia contradicts the additional fine-tuning for the appearance of intelligent life

Globular star clusters, for example, could be very good for panspermia, but bad for intelligent life, as frequent supernovas will destroy complex life on surfaces of the planets, but not affect simple lifeforms inside the crust. But as we noted before, we assume that the probability of intelligent life appearing on a planet with life is constant. If there is a universe with panspermia but without complex life, we ignore it in our calculations, because we look only on those universes where we could appear and could use anthropic logic for trying to explain the ways of our appearance.

Thus, there should be constrain of intensity of panspermia, which limits density of stars, intensity of impacts and maybe power of gravitation. Our universe seems to be in the Goldilocks position for panspermia: while some stars are densely packed and have intense impact events in early period of formation of planetary systems and thus favor *spreading live*, other systems (like Solar system) are more adapted for *receiving life* and giving it an opportunity to evolve, as they are located far from the places of intense star formation and have lower impact rate in later evolution.

## 5.3. Objection 3. The fine-tuning of universes for panspermia is not only rare in itself, but creates smaller Hubble-volume-universes or fewer stars per such universe, thus lowering the total number of stars

Panspermia requires the existence of many stars in relatively dense formations, which contradicts the idea of empty Hubble volumes. The existence of other galaxies is mostly irrelevant for interstellar panspermia and the number of observers its creates: a single galaxy is enough.

## 5.4. Objection 4. Panspermia could be replaced with “easy abiogenesis”

In some universes, it could be very easy for life to arise. The main difference between a panspermia-universe and an easy-abiogenesis-universe would be the life in other galaxies. In a panspermia universe, life would be present only in our galaxy, so the Milky Way might have some special features, like different spectrum in some frequencies because of a higher abundance of organic molecules. If an easy-abiogenesis-universe typically allows the appearance of only one instance of life per galaxy, but only some galaxies are favorable for panspermia, we are still more likely to be in a panspermia galaxy.

The question could be reformulated: "what is easier: panspermia or abiogenesis?" If we look at Earth, we can see that "panspermia" between different parts of the Earth worked better than abiogenesis: we have only one type of life here. The final answer could come from Mars: if we find life there, and it is of a different origin than that on Earth, then abiogenesis is easier. If there is life that is our genetic relative, that will be evidence for easier panspermia.

Panspermia universes will dominate only if abiogenesis is a task of irreducible difficulty for all (or almost all) universes in the multiverse. If abiogenesis could be broken into several simpler steps, than easy abiogenesis universes will dominate by the number observers they create—but the result will be almost the same as for panspermia—the abundance of life in the universe. The difference is that life will be also plentiful in remote galaxies, and there will be more chances to find civilizations in other galaxies or be colonized by them.

## 5.5. Objection 5. The general difficulty of interstellar panspermia and the fact that life on Earth evolved from the simplest organisms may be an argument against panspermia

However, it could have taken place as panspermia of short RNA chains, which created RNA-worlds everywhere. Such chains should be more stable in space, as they could freeze. However, this would mean that some form of RNA world should continue on Earth, which we have not found. Panov (Panov, 2015) argues for such pre-biological panspermia.

## 5.6. Objection 6. Some other process may have a higher impact than panspermia on the distribution of the mass of observers (e.g., simulation argument or fecund universes)

In other words, some *anthropic monster* exists. However, this would not exclude panspermia, as it also could be simulated. If our simulation objectively models all the physics of our space and time, including Darwinian evolution, why it should stop doing so for panspermia? This argument would work only if there is a difference between simulations created by civilizations in panspermia universes and those created by civilizations in non-panspermia universes. In other words, there would be more civilizations in panspermia universes, and more simulations of their past created by these civilizations. So, most simulations would model panspermia universes.

One may insist that a world could be simulated with different laws of panspermia than exist in the real world of the simulators. To object this, I suggest a general principle: "*Most facts about the outside world in the most simulations are true*". I will prove it based on the contrary evidence: imagine that in all simulations created by all possible civilizations there is a lie *A*, while in the real world non-*A* is true (e.g. 2 + 2 = 5 or the Sun is square). In that case, there should be a coordination process applicable to all possible civilizations which create simulations. However, there is no such physical process. So, all simulations can't share one lie. (There is one exception: all simulations lie that they are real world).

## 5.7. Correlation counterargument

The following counterargument was [suggested](https://www.reddit.com/r/GreatFilter/comments/fggfya/anthropic_effects_imply_that_we_are_more_likely/) in online discussion of this idea: “You also have to take into account the correlation between planets where life begins and planets where life becomes intelligent. If that correlation is zero or negative, then the argument holds up quite well. But if that correlation is strongly positive (that is, life is vastly more likely to become intelligent on the same sort of a planet where it is likely to originate), then the argument becomes much weaker.”

In other words, if panspermia works only to deliver life from Earth-like planets to comets and between comets, but not back to planets, then almost the entire galaxy will have comets with life, but there will be no increase in the number of terrestrial planets with life. An anthropic increase in the number of observers will occur only in those universes where full-cycle panspermia (planet to planet) is present and abiogenesis is difficult.

## 5.8. Objection 8. If the Earth and our solar system are unique, panspermia will not result in an increase in the number of the civilizations in the galaxy

We started by assuming that there are 10 billion Earth-like planets in the habitable zone in the Milky Way galaxy. However, such planets may not be suitable for the rise of civilization (e.g., because of intense asteroid bombardment or atmospheric instability). We discuss several such filters in our article about “anthropic shadow” (forthcoming). But even if there is only one civilization for each panspermia universe, such universes could still dominate with the number of civilizations they create. This is because panspermia will help to deliver life from the place of its origin to the only planet suitable for civilization to arise, even if that planet is halfway across the galaxy. The early appearance of the life on Earth contrasts with a rather late appearance of the Earth in the history of our galaxy, which may be explained by panspermia. In galaxies without panspermia, suitable planets will stay sterile or will require more time to develop life and will have no time for the development of civilization before their stars become red giants.

## 5.9. Objection 9. We should find ourselves much earlier in the history of the universe with panspermia

But the possibility of panspermia does not mean an earlier appearance of the first instance of life in the universe if abiogenesis is really difficult. In any case, panspermia implies that civilizations will appear *earlier*, because the number of planets with life grows exponentially with the progression of panspermia. This also means that the first civilizations will all likely be of approximately the same age. It is known that the Earth appeared when there was a maximum of possibly habitable planets in our galaxy, and this period is most favorable for panspermia (Franck et al., 2007).

## 5.10. Objection 10. Self-indication assumption is either false or inapplicable to infinite universe

Presumptuous philosopher thought experiment is illustrating the Self-Indication Assumption. But this assumption could be either false or inapplicable to the infinite universe. We already discussed SIA in section 2.2.

The alternative to SIA is Self-Sampling Assumption (SSA). The idea behind SIA could be illustrated as following: if there is a rare card in the deck and it was picked, it is the evidence that large number of such picks has happened before correct pick. If someone won in a lottery, it is likely that this person has been buying many tickets before his win. SIA uses the same logic, but applicable to the own existence of the observer: the fact that I exist at all is the evidence that there was larger number “attempt” to create me. SIA correspond to “thirder” position in Sleeping Beauty.

Bostrom formulated it as following: “SIA: Given the fact that people exist, people should (other things equal) favor hypotheses according to which many observers exist over hypotheses on which few observers exist.” However, SIA works only in the finite universe. For example, if we know that all cards were drawn from a deck, the fact that a special pre-selected card (like ten of ace) was drawn provides no new information. (Moreover, SIA itself – in the form of presumptuous philosopher thought experiment – is an argument for the infiniteness of the universe as it will have infinitely many more observers than any finite one.)

If two hypothesis claims that there will be infinite number of observers (of the same cardinality class), SIA doesn’t help to choose between them.

If all possible combinations are already drawn, SIA turns into SSA: in that case, my mere existence is not evidence for anything, but I should find myself in the largest part of the observers of my reference class. For the card case, “numbers” are more probable than “figures”, so getting ace of 2..10 is more probable. For the observers’ case, I am more probable to be a typical observer living in the middle of history, so Doomsday argument is true. Note that SSA also become undefined in the case of infinite number of observers.

To escape the infinity curse, we first should note that the total number of possible humans is finite, as there is a finite number of combinations of atoms composing a human brain. In sufficiently large, but not actually infinite universe all those observers would exist. Actual size of such universe was calculated by Tegmark, and such large size could be created by chaotic cosmological inflation (Tegmark, 2009).

One problem of the infinite number of unordered observers is that to select an observer, the selection algorithm should be infinitely long. In real physical world, there is no such problem, as a chain physical processes produces observers: Big Bang and then evolution. If we ignore some crazy observers like Boltzmann brains, this physical process of creating different minds has some distribution of the probabilities of outcomes. And exactly here we can speak about higher probability to be in the panspermia universe than in non-panspermia universe, the same way as we can discuss other properties of observers: for example, I am more probable to be born from an ordinary man than from a king, just because the number of ordinary men is higher and the process which creates observers is more often produce sons of ordinary man.

But this process has happened infinitely many times if the universe is actually infinite, and if we have an infinite number of elements, they could be numbered in different orders: for example, if we have infinitely many kingdoms, we could number kings and ordinary men in the way that for each king here will be just one ordinary man: we take first king from a first kingdom as 1, then an ordinary man from the first kingdom as 2, then a king from second kingdom as 3, then an ordinary man from the first kingdom as 4 etc.

We will not try to solve the problem of counting infinities here. Instead we should note that this problem doesn’t affect probabilities distributions in real life: I am still not a son of a king and in all testable situations I am more likely to belong to the largest group of suitable observers. Our civilization also should be typical between all remotely existing civilization and if panspermia affects this distribution, it also proportionally changes our chances to be in the panspermia-universe.

Even if there is no infinite universe and observable universe is all that actually exist, the argument stands, if applied to *galaxies*: we are more likely to find ourselves in the galaxy which allows creation of higher number of observers, and the galaxies which allows panspermia are more likely to produce more observers. It is not clear if the differences in galaxies are enough to make some galaxies prone to panspermia while other are not. Such difference should include distance between stars and lower intensity of galactic radiation in the interstellar space, which could damage seeds of life. Note that the argument does not require *actual exiting* of the galaxies-without-panspermia-but-with-civilizations: in a *finite* universe could be a situation that life evolves into civilization only in panspermia-suitable galaxies, and others types are possible but so rare that they never actually happen.

## 5.11. S. Armstrong’s objection: SIA doesn’t favor the power of panspermia over other types of Early filters

S. Armstrong [argued](https://www.lesswrong.com/posts/xfEsxAtBTLgFe7fSZ/the-sia-population-update-can-be-surprisingly-small?commentId=vwPJvDTkypa9hfivQ) on LessWrong that “Anthropic updates do not increase the probability of life in general; they increase the probability of you existing specifically (which, since you've observed many other humans and heard about a lot more, is roughly the same as the probability of any current human existing), and this might have indirect effects on life in general. So they does not distinguish between "simple life is very hard, but getting from that to human-level life is very easy" and "simple life is very easy, but getting from that to human-level life is very hard". So panspermia remains at its prior, relative to other theories of the same type (see [here](https://www.lesswrong.com/posts/wgHbNZHsqfiXiqofd/anthropics-and-fermi-grabby-visible-zoo-keeping-and-early#Rare_Earth_hypotheses)). However, panspermia gets a boost from the universe seeming empty, as some versions of panspermia would make humans unexpectedly early (since panspermia needs more time to get going); this means that these theories avoid the penalty from the universe seeming empty, a much larger effect than the anthropic update (see [here](https://www.lesswrong.com/posts/wgHbNZHsqfiXiqofd/anthropics-and-fermi-grabby-visible-zoo-keeping-and-early#Time_enough_for_aliens)).”

My reply: I am still not convinced: it seems that p(abiogenesis) is a very small constant depending on a random generation of a string of around 100 bits.  The probability of life becoming intelligence p(li) is also, I assume, is a constant. The only thing we don't know is a multiplier given by panspermia, which shows how many planets will get "infected" from the Eden in a *given type* of universes. This multiplier, I assume, is different in different universes and depends, say, on the density of stars.  We could use anthropics to suggests that we live in the universe with the higher values of the panspermia multiplier (depending of the hare of the universes of this type).

The difference here with what you said above is that we don't make any conclusions about the *average global level* of the multiplier over all of the multiverse, you are right that anthropics can't help us here. Here I use anthropics to conclude about what region of the multiverse I am more likely to be located, not to deduce the global properties of the multiverse. Thus, there is no SIA, as there is no "possible observers": all observers are real, but some of them are located in more crowded place.

In other words, SIA can’t update the probability of panspermia, but SSA tells us that we are in the region of the universe where panspermia is more probable. As was discussed in section 2.2, in the infinite universe SIA and SSA essentially merge, so SSA becomes analogue of SIA, and presumptions-philosopher-type of arguments still work.

## 5.12. Other objections

Some other objections were presented during [online discussion](https://www.reddit.com/r/GreatFilter/comments/jxp0yd/we_are_more_likely_to_be_in_the_universe_with/) of the preprint and below are the objections and my short replies:

* “There's been very little direct evidence of panspermia. It seems like something that should be happening but we haven't actually seen it happening.”

Reply: We don't see panspermia, but we see surprisingly many needed elements: meteorites from Mars, interstellar comets etc. Our universe looks like the one where interstellar panspermia is possible.

* “We do not see any ruins of past civilizations, either on Earth or elsewhere, so it seems like the filter should be leaving behind environments that are no longer suitable to support civilizations (but without creating an easily detectable signature across interstellar distances).”

Reply: We don't see alien ruins – so the filter should be very near, something like complexity crisis for technological civilization, resulting in nuclear-biological war. Or – as discussed in section 6 – we are the first.

* “If panspermia works, it would tend to select for life forms that thrive on comets/asteroids/etc, and if it is at all possible for those environments to support civilizations, then there should be many more observers living in those environments than on planets, but we live on a planet.”

Reply: Comets are either carriers of a frozen biological material, or of very slow and simple life forms which could live in them (and in any water-worlds under surface, like Enceladus). Multicellular evolution and civilisations need a lot of energy, which could be provided only by terrestrial planets.

* “If civilizations at our own level were present in a relatively dense distribution in our galaxy, we could probably already detect them, and we don't.”

Reply: As is discussed in the paper in section 6, one of the solution is that we are just one of the first civilisations, as first civilisations will start the colonisation wave. If we are one of the earliest, but not exactly the first, alien colonisation wave will arrive soon.

* “There should be many more observers in universes without filters at all, but almost all of those observers should not find themselves living near the beginning of their civilization, but we do.”

Reply: Discussion about why we are not late observers in advance civilizations puts us into realm of the Doomsday argument, and its solution doesn't depend on panspermia. Maybe the Later filter is very strong and most civilisations go extinct (K. Grace solution (Grace, 2010)). Maybe the number of simulations is so large that most of the observers are in the simulations of the past (Simulation Doomsday argument (Turchin, 2018a)). Maybe the fact that we ask this question means that our position is not random and thus DA is not applicable to us.

Hanson [said](https://www.overcomingbias.com/2020/12/searching-for-eden.html#disqus_thread): I'm questioning your claim that panspermia gets an anthropic boost. All late filters get a boost, but that doesn't favor panspermia any more than weaker early filters…. That is, as I said, just the effect that weaker filters produce large populations later. This effect equally favors weaker early filters of all sorts. But to satisfy the min bound on the great filter, making these easier forces one to make others harder.

Me: Yes, all late filters get the boost because of SIA doomsday by K. Grace. But panspermia has an increase in probability even before it is applied, because its effect on the number of observers is very significant as it (a) solves abiogenesis, (b) includes many more planets in the game, (с) and provides life on these planets quickly, so they have more time to play with other filters. In other words, panspermia is a part of the explanation why early filters are less likely according to SIA doomsday.

Let's try to compare. Imagine that in the first galaxy there is no early filters: any planet with life will get a civilization. Firstly, it works for both galaxies, so this does not affect the probability of panspermia, as both galaxies will get proportional burst in the number of civilizations. Secondly, the effect of all other early filters canceling is limited: it can't be more that P(survival)=1, but for panspermia it is not limited as it allows inseminating the whole galaxy. However, the galaxies with easy abiogenesis will have even more observers, if such worlds are possible.

## 5.13. Intense panspermia is more likely to be observed than rare and accidental

General anthropic considerations are so strongly favor intense interstellar panspermia that they make all other pieces of evidence irrelevant: a universe with panspermia will produce billion times more observers than non-panspermia universe, as a) abiogenesis is simplified b) almost all potentially habitable planets in a galaxy will be inseminated and there are billions of them.

Speaking about Eden (where life appeared firstly), it should be a planet with very large V, and large water world or underground ocean like on Enceladus seems to provide large V, like 100 km depth.

Intense panspermia, where Eden created many "children" which pass through several other water worlds in a few generations is more likely to be observed as it creates more observers. Hanson about Eden <https://www.overcomingbias.com/2020/12/searching-for-eden.html#disqus_thread>

## 5.14. Panspermia doesn’t exclude Rare Earth theory if we look at other filters’ distribution

Panspermia “solves” abiogenesis as a possible early filter, however, it doesn’t translate into a large number of alien civilizations until we assume that there are a lot of habitable planets in our Galaxy.

There are two forces in conflict: firstly, because of SIA, we are likely to find ourselves in the galaxy with highest possible concentration of habitable planets. However, because of anthropic shadow, we could find ourselves only in on habitable planet, no matter how unlikely is its creation. Recent article of Sandberg et al (Snyder-Beattie et al., 2020) shows that the number and distribution of major evolutionary transitions (sex, eukaryotes) in the history of Earth can’t exclude the situation when each evolutionary transition typically required an order of magnitude more time, like ten billion years.

Moreover, there are “negative filters”: that certain catastrophes should not happen, and some catastrophes have high frequency, but we just can’t observe them in our past, but they could return with vengeance in the future. There are also several very specific necessary conditions for the complex life, like the location of the Sun in the galaxy, the unusual stability of the Sun, the existence of Moon, the existence of Jupiter which protects us from comets, and very specific course of evolution of atmosphere on Earth, which escapes turning into runaway global warming or snowball (Turchin & Denkenberger, 2019a).

There is an upper limit on all other filters: combined the should ensure that we don’ not observer aliens. Panspermia kills abiogenesis as filter, and this increases chances of all other filters, but if this increase is distributed uniformly, it increases chances of each filter only slightly, without giving each decisive advantage. (Note that very strong early filter doesn’t completely kill the SIA-Doomsday by Grace, which still implies that the Late filter is ahead. For example, if early filter is so strong that only 1000 civilization will appear in observable universe, and all of them has perished, it still means that later filter has 99.9 chances.)

# 6. Implications for existential risks, the Fermi paradox, and the future of humanity

## 6.1. Effects of space colonization on the civilizations’ distribution in the panspermia universe

Colonization by the first civilizations will lower the number of the civilizations in the panspermia-universe thus cancelling panspermia effect. Many assume that the first civilization will start a colonization wave, and it will take only a few million years for such wave to cover the size of a typical galaxy like Milky Way (Armstrong & Sandberg, 2013; Hanson, 1998; Hanson et al., 2021; Olson, 2020). The colonization wave will benefit from the presence of habitable planets, where colonist can settle. But doing so will prevent the appearance of other civilizations on these planets.

One exception is civilizations slightly younger than our own, too young to start their own colonization but already mature enough to observe the arrival of an alien colonizer. In other words, panspermia makes space wars and “alien invasion” much more probable. If there are 1 billion civilizations which could appear in a panspermia-galaxy without accounting for colonization effects, they will appear every 1–10 years, depending on the duration of galactic habitability window (when habitable planets could appear) which is few billion years long. If galactic colonization requires around 1 million years, then around 1 million civilizations will already appear after the first civilization has already started its process of galactic colonization—and we are likely to be one of them. The achievable speed of the Orion nuclear spaceship is 0.2с and the diameter of Milky Way galaxy is around 100k ly. This means that Orions could cross it in 500 000 years and adding time for deceleration and building new ships gives around 1 million years. Advance nanotech may give much quicker colonization, with almost lights speed, and as most civilization will be in galactic habitability zone at 25ky from the center, it gives total colonization time around 50ky.

If we are one of those civilizations, there is a large chance (like 1 million to 1) that we will be victims of alien colonization and not the (future) starters of it. Berezin pointed out that the most probable explanation of the Fermi paradox is that we are the first and we will kill everybody else (Berezin, 2018). But his explanation does not consider that we could be a younger civilization that appeared just before the arrival of the colonization wave. Thus, the total number of civilizations ever appeared in the galaxy will be 1000 times less than initially estimated number of 1 billion civilizations, and they will appear almost simultaneously. If they appear earlier than the time of the beginning of colonization, they will start the colonization themselves—and they will not be able to appear later, as most planets will be already colonized.

In other words, because of the panspermia, our sibling civilizations are almost the same age as we and are located surprisingly near us; only a small difference in age will determine who will be colonizers and who will be victims of colonization. As the number of victims is larger, we are likely to be ones. The median arrival time of colonization wave is a *half* of the time of intergalactic colonization wave which we estimated between 50-1000 ky, because we observer such wave in a random moment. Thus, it is between 25 and 500 ky. This is in a striking contradiction to the Hanson’s model where grabby aliens appear independently and are very remote, so the median time until the encounter with alien colonization wave is around 1 billion years.

However, if the distribution of appearance of civilizations in time will likely be normal, then the first civilizations will appear at a slower rate than the expected median rate. This is because only a few civilizations are in the *early tale* of the distribution and they will be first. There will be fewer or no simultaneous civilizations if we account for a normal distribution. If there are no simultaneous civilizations, we are likely either to be the first civilization, or to be living in a *space zoo* (Ball, 1973). Otherwise, if several civilizations are first and reaches maturity simultaneously, there should be many colonization waves in the galaxy, started by the few first civilizations. Such waves would hit each other and result in space wars along borders, which would presumably be observable—but we have not observed or recognized any. The main feature differentiating the panspermia from the easy abiogenesis universe is that there are no invaders from other galaxies, as only our galaxy is “special” and hosts life.

A historical example of panspermia and a colonization wave is the interaction of European colonizers with other human cultures. The initial human settlement around the Earth could be seen as an analogue of panspermia. American Indian civilization evolved with a small lag of around few thousand years from European, and so it “observed” the arrival of Europeans and its own destruction. If American Indians evolved quicker, the situation could have been the opposite. Human settlement around Earth entailed the synchronized timing of different cultures and their meeting during a period with a relatively small but decisive technological difference, favoring Europeans.

## 6.2. Great Filter is ahead in the panspermia universe

If we are in a panspermia universe, it means that the Great Filter of the Fermi paradox is likely ahead, as the major abiogenesis filter has not prevented many planets in our galaxy from having life. Thus, the Rare Earth hypothesis is false locally, in our galaxy. Bostrom has analyzed the relationship between the risk of a future filter of civilizational self-destruction and abundance of extraterrestrial life in his article “Where are they? Why I hope the search for extraterrestrial life finds nothing” (Bostrom, 2008). His main idea in that work is that if there is life on Mars, there are fewer chances of an Early Filter, and thus more chances of a Later Filter, that is, that almost all civilizations self-destruct. The latter means that our civilization is also likely to self-destruct.

Hanson: “Given the great silence, we have a lower bound on the total filter. So if panspermia creates a negative filter at some stage, that must be compensated by even larger positive filters elsewhere.” <https://www.overcomingbias.com/2020/12/searching-for-eden.html#disqus_thread>

Alternatively, the lack of an Early Filter means that there are many civilizations in our galaxy, which are hiding and thus could be hostile (Turchin & Denkenberger, 2019b)—or that a later filter is so effective that it wipes out all civilizations before they start a wave of space colonization. As we said above, we are likely to be among the earliest civilizations, but not the first, and the wave of colonization will arrive soon. So, there are three alternatives, all unpleasant(a) *a dark forest* solution of the Fermi paradox in which everybody else is hiding, (b) *inevitable self-destruction* of any civilization, (c) *an* *alien colonization wave* will arrive soon. Another possible explanation is that there are other, earlier great filters, like a higher level of asteroid impacts or difficulty in achieving multicellularity.

If humanity becomes an interstellar civilization, we will encounter many planets with life, and even intelligence. Ethically speaking, colonizing such planets is not the same as simply harvesting dead space (Hanson, 1998). After the start of the interstellar expansion, we should expect to find planets with life and potentially habitable planets with oxygen-rich atmospheres (though an advanced civilization may prefer build colonies on asteroids and transcend biology). There will be an ethical tradeoff between preserving such life and converting such planets into human colonies.

Radio-SETI seems more reasonable in case of panspermia, as such an origin for life implies the existence of many civilizations of approximately our age nearby (Panov, 2005). These life-forms would also be our “brothers”, as they share some of our DNA, and may be more similar to us than independent life forms based on completely different principles. Indeed, panspermia increases the chances that another civilization has visited the Solar system in the past, or that we could find some technological remnants from it, like self-replicating robots (Carrigan Jr, 2012). Regardless, if it occurred, there could be evidence of interstellar panspermia in the solar system—on Mars and inside large cold comet bodies and satellites with oceans. Thus, the search for life on Mars should be prioritized. Recent signs of life on Venus (Greaves et al., 2020) also deserve thorough investigation.

However, if there is no universal Great filter, alien colonization wave could arrive soon, as the distances inside the galaxy is relatively small and could be covered in few million years in weakest case, and also because we are more likely to be located in the regions of the galaxy which colonization waves didn’t reach yet.

SETI-attack – sending descriptions of malicious AI in order to take over a naïve civilization (Carrigan Jr, 2006; Turchin, 2018b) – could also happen in such densely packed galaxy. Knowing that, civilizations could prefer to play “dark forest” strategy and remain silent or exchange data via trusted channels (Kerins, 2020).

## 6.3. Self-Indication Assumption and solutions to the Fermi paradox

SIA-Doomsday argument by K. Grace (Grace, 2010) also claim that Great Filter is ahead, because more civilizations are in the universes with later filter than in the civilizations with early filter. As SIA-Doomsday is based on almost the same logic as we presented here for high probability of panspermia universes, they both likely true simultaneously (or both false). In that case, we live in the galaxy where many civilizations had appeared because of life proliferation via panspermia, but almost all them died before they started interstellar space colonization. One consequences of this is that their remnant and perhaps dangerous remnants could be eventually found via space exploration (Turchin & Denkenberger, 2019b).

SIA favors not only panspermia, but the existence of multiple potentially habitable planets in the galaxy, as, repeating all the above logic, we could show that intelligent life is more likely to appear in the Galaxy which has more potentially habitable planets than just one. Thus, we are likely to find ourselves not in the world where panspermia is mere possible, but there it actually works as there are all needed ingredients including habitable planets. This is just a part of general stance of SIA against all types of early Great filter. This left very small cleft where catastrophic Great filter could work: it can’t be before us, but it also can’t be in the remote future, as advance AI can’t be the great filter. In other words, SIA works only for *successful panspermia* which actually increases the number of observers, but not (or much less) for *empty panspermia* which helps to bring life to only one planet, Earth.

This leave us only with a very limited set of hypothesis:

* Earliest late Great filter, that is something which could happen very soon, before AI, like Biological war (Cooper, 2013) + other technological risk which do not include AI.
* Zoo hypothesis (Ball, 1973), which include all variants that they are here
* We are the first and will kill everybody hypothesis (Berezin, 2018).

Early appearance of life in the history of Earth, almost immediately after its formation, is an argument for panspermia or easiness of abiogenesis. This may not be applied to other events in the history of life, which could be affected by anthropic shadow as Sandberg et al showed in recent article (Snyder-Beattie et al., 2020). They listed several plausible early filters: eukaryotes, sex and intelligence.

However, many of things which were previously regarded as filters, are unlikely to be them, like eukaryotes (chloroplasts), multicellularity or growth of intelligence (dolphins), as they happened a few times in the history of Earth as was discussed by Armstrong (Armstrong, 2014).

## 6.4. If SIA is false, it has significant consequences for our prospects

Sandberg et al in recent article chose to ignore SIA, but acknowledge its power: “For example, if we posit only two possible universes, one with 10 human-like civilizations and one with 10 billion, SIA implies that all else being equal we should be 1 billion times more likely to live in the universe with 10 billion civilizations. If SIA is correct, this could greatly undermine the premises argued here, and under our simple model it would produce high probability of fast rates that reliably lead to intelligent life… However, embracing SIA leads to a number of other very counterintuitive results, such as essentially guaranteeing that the universe is exceptionally large or infinite even without accounting for cosmological evidence (Bostrom and Cirkovic, 2003), or giving substantial probability to any bizarre theory that proposes a large enough population of observers to overwhelm the a priori implausibility of the theory (e.g., a theory that each planet has 10^10^100 copies of itself on ‘‘other planes’’ would seem hard to refute if one adopted SIA) (Olum, 2002). Adopting SIA thus will undermine our results, but also undermine any other scientific result that would suggest a lower number of observers in the Universe.”

If one chooses to deny SIA, and assumes SSA instead, he could escape presumptuous philosopher’s superhuman predicating power about panspermia, but the price is that he then should accept classical Doomsday argument, which says that based on our early position in history, the civilization will end soon.

Also, if SIA is false, then intense anthropic shadow becomes possible (Snyder-Beattie et al., 2020) which means higher probability of natural catastrophe than we could conclude from observation and higher anthropic fragility of our environment, first of all, higher chances of runaway global warming and lower tipping points on climate (Turchin & Denkenberger, 2019a). In short, either panspermia is true or runaway global warming is near.

## 6.5. Nanotechnological panspermia

Nanotechnological panspermia is possible via the same ways as panspermia for life. Nanobots could survive in rocks and travel between star systems. If a civilisation had created nanobots and then went extinct, such nanobots will eventually inseminate the whole galaxy.

If alien nanobots are grey-goo-style thing, we can't observe them, as we will be killed before such observation will be possible, but if they are slow replicating things, they can live almost unobservable everywhere.

## 6.6. SIA is an argument in favor of multiverse and many-world interpretation of quantum mechanics

If everything-that-exists (true multiverse) would be limited in size and randomly chosen from all possible worlds, it would be quite likely that no observers will be there. The needed condition here is that most possible worlds are unable to create observers. As we exist, this seems to be not true. Everything-that-exists needs to be large enough to include worlds where observers are possible. It doesn’t need to be necessary infinite. This is also discussed in (Barrau, 2014; Parrochia, 2020) <https://arxiv.org/pdf/2001.03771.pdf>

In cosmology, it is an argument in favor of both eternal inflation, as it creates more galaxies similar to ours, and string landscape as it creates many universes with different physical properties. For example, if there are two regions in primordial universe, one with eternal inflation, and another with only limited inflation, we are more likely to observe ourselves in the region with eternal inflation as it is infinitely larger. Cosmological inflation suggests that the real size of the universe is 10-100s orders of magnitude more than visible universe: obviously, it creates more observers than if only visible universe existed. Eternal inflation creates even more observers as in this model inflation never ends (Linde, 1983).

The same way, MWI assumes the existence of much larger number of observers than other interpretations of quantum mechanics and thus it should be true under SIA. There is a question here how observers should be counted here. If we take only branching, the number of observers grows orders of magnitude every second, and this creates a specific form of the Doomsday argument: I should find myself in the last moment of all observers’ existence (this is similar to Grace’s SIA doomsday which favors Late filter, but stronger). If we discount the measure of all observers so doesn’t change in time, my personal measure will decline extremely quickly, and I should find myself an infant.

SIA also favors *evo-devo universe* which replicates via black holes (Smolin, 1992) maybe with the help of civilization which perform some experiments.

SIA favors “measure monsters”, probably created by advance AIs to win “measure war” and control the biggest amount of consciousness in the universe (Turchin, 2020).

Boltzmann brains should have a low total measure or we are BBs (Turchin & Yampolskiy, 2019).

SIA also support self-confirming loops in time, where observer is stack in closed time-like curve. Thus, the worlds where time travel is possible are more likely.

Note that these ideas stack on each other: we are likely to be both in evo-devo self-replicating universes *and* in simulation. There is way to calculate such infinite probabilities by assuming the existence of eternal geodesic line which can survive in black holes and big bangs: the probabilities become frequencies of its location in some conditions (Garriga & Vilenkin, 2013).

Youngness paradox by Gut overrides alien existence and many other PP consequences as it states that cosmological inflation increases the total number of universes 10E37 every second and thus we are likely to be in the youngest universe and the first civilization.

## 6.7. SIA favors panpsychism and the world full of angels, but I am not where, so they are strongly false

On absurd metaphysical level, one may try to use SIA to prove panpsychism and spiritual world, as both of them have more “observers”. But here it actually doesn’t work as I should be a stone (as there are many more conscious stones in panpsychism than humans) or an angel, but not a human being.

This means that worlds with panpsychism or complex spiritual world are impossible or extremely rare, and thus most observers are not in them.

## 6.8. SIA favors Zoo hypothesis

Robin Hanson created a model of grabby aliens (Hanson et al., 2021). In this model, we live before the arrival of an alien colonisation wave, because such a wave will prevent the appearance of the new civilizations. Thus, we could find ourselves only before the arrival of the aliens if any exists in our Universe.

However, at least some of the colonisators will preserve a fraction of habitable planets for different reasons: ethics, science, tourism, neglect. Let’s assume that it will be 0.01 of the total colonized volume. The numbers could vary, but it still looks like that in a densely packed universe the total volume of colonized space-time is significantly larger than the space-time for habitable planets before colonization arrival, and thus even a fraction of this volume could be larger than the volume of the virgin habitable space. This is because the colonized space will exist almost forever until the end of the universe.

Moreover, any small effort from the alien civilization to seed life (artificial panspermia) or to protect habitable planets from catastrophes like asteroid impacts will significantly increase the number of habitable planets inside the colonization zone. Hanson’s model also assumes that the probability of civilization appearance for any given planet is growing with time, so later regions will have a higher density of habitable planets, as more planets will reach this stage.

Given all this, our civilization has higher chances to appear after the colonization wave has passed us and thus aliens need to be somewhere nearby, but hidden, which is known as the Zoo Hypothesis. In other words, we live inside the sphere of influence of Kardashev 3 civilization which either helped our appearance via artificial panspermia etc or at least do not prevent our existence.

In this formulation, the idea starts to look like a variant of the simulation argument as here it is assumed that an advance civilization could create many non-advance civilizations.

It was [suggested](https://www.uaptheory.com/) that aliens could use the modification of the geodesic lines in space-time for instant acceleration and moving through matter. This may explain some observed properties of UAP and lack of classical spacecrafts visibly arriving to Earth. Absurd behavior of the UAP could be explain as behavior of tourists.

Hanson [suggested](https://www.overcomingbias.com/2021/03/do-foo-fighters-show-our-snafu-fubar-future.html) that we are likely to observe aliens which was created by catastrophically inefficient organizations. I agree that we are more likely to observe inefficient aliens, which fail to convert all matter in some computronium, because efficient aliens kill all complex life as soon as they arrive. So even if inefficient and absurd aliens are rare, we are more likely to observe them than other types. Absurdity explains observability. I also discuss this idea in “UAP as global risk” (Turchin, 2013).

From all types of Zoo, SIA favors the zoo which is more like national park – large territory with smaller control from the foresters. Most of the wild animals on Earth live not in city zoos or in in perfect wild sanctuaries, but on some territories where control and industrial exploitation are combined. This means that alien “tourists” and “poachers” are more likely to appear here and will not be prosecuted for small violations, like visibility and taking artefacts. This is supported by some recent UAP observations; however, ghost rockets are more an argument for “alien animals” or “material dreams” – otherwise we should assume that aliens were surprised by rockets. (The same is true also for simulation, where perfect simulations of the whole universe are rare, and simple, rough are more frequent.)

Such “light-zoos” are more probable in the universe where the number of habitable planets is large, so each habitable planet is not of high value. The panspermia-universe provides such large number of habitable planets.

# Conclusion

In this paper, we demonstrated that panspermia is favored by observer selection effects under certain plausible conditions. This means that either the Great Filter is ahead for us and there is a high risk of anthropogenic extinction, or that there are many alien civilizations hiding nearby—itself another global catastrophic risk. A search for life on Mars could help us to resolve this conundrum, which means we should not rush to terraform that planet.

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## Comments:

The "Wow! signal" of the terrestrial genetic code

<https://arxiv.org/abs/1303.6739>

<https://iopscience.iop.org/article/10.1088/0031-8949/92/1/013002?fbclid=IwAR3rYv6eK2FAQqSG4wSKr5KIcyZcy37wYBRCQvPhb4Mv9F-V-L9dR_JaGK8>

[**Stephen Ashworth**](https://www.facebook.com/groups/270650306292217/user/506117519/?__cft__%5B0%5D=AZU-d7neE3Im5pjbsqU5doC4xViV_oYkddgXISiVA4CjF3M9dwBVx1XPJy6vdmwBEaXgU3HTb3tKJ8DW_y7dJn8td6gEwJo4dq5db1JCuP2H0nKGqX0W7zKoFyBs6P1xXZzsJpYEXdTntUuZfqmIiorm&__tn__=R%5D-R)

"universes with interstellar panspermia have more observers and thus we are likely to be in such universe" – Assumes that more than one universe exists, and that humanity is a random sample from them, neither of which assumptions has any evidence that I know of.

Me: Stephen Ashworth Actually, we can reason not about universes, but about galaxies in our universe: if there are two types of galaxies: with panspermia and without, we are likely to be in the ones with panspermia, based on copernican mediocracy principle.

[**Alex Newberry**](https://www.facebook.com/groups/270650306292217/user/1021727992/?__cft__%5B0%5D=AZU-d7neE3Im5pjbsqU5doC4xViV_oYkddgXISiVA4CjF3M9dwBVx1XPJy6vdmwBEaXgU3HTb3tKJ8DW_y7dJn8td6gEwJo4dq5db1JCuP2H0nKGqX0W7zKoFyBs6P1xXZzsJpYEXdTntUuZfqmIiorm&__tn__=R%5D-R)

**[Alexey Turchin](https://www.facebook.com/groups/270650306292217/user/1562091030/?__cft__%5B0%5D=AZU-d7neE3Im5pjbsqU5doC4xViV_oYkddgXISiVA4CjF3M9dwBVx1XPJy6vdmwBEaXgU3HTb3tKJ8DW_y7dJn8td6gEwJo4dq5db1JCuP2H0nKGqX0W7zKoFyBs6P1xXZzsJpYEXdTntUuZfqmIiorm&__tn__=R%5D-R)**

 You cannot use the word 'proves' when you have no proof. To prove a theory correct you need evidence. Evidence would obviously include examples of life, in whatever form of life that may take; from other worlds.

Me: If we assume "presumptuous philosopher thought experiment" logic, it gives very strong probability shift in the direction to panspermia. Knowing this, we could intensify our search of direct evidence on Mars and comets.

Is it possible to use your model to the situation when several civilizations appear almost simultaneously in a one galaxy because of panspermia and all other galaxies are empty? They will start colonisation waves in that galaxy which will collide relatively soon.

* + [−](https://disqus.com/embed/comments/?base=default&f=overcoming-bias&t_i=32714%20http%3A%2F%2Fwww.overcomingbias.com%2F%3Fp%3D32714&t_u=https%3A%2F%2Fwww.overcomingbias.com%2F2021%2F02%2Fhail-s-jay-olson.html&t_e=Hail%20S.%20Jay%20Olson&t_d=Overcoming%20Bias%20%3A%20Hail%20S.%20Jay%20Olson&t_t=Hail%20S.%20Jay%20Olson&s_o=default" \o "Collapse)

[](https://disqus.com/by/sjayolson/)

[**Jay Olson**](https://disqus.com/by/sjayolson/) [turchin](https://www.overcomingbias.com/2021/02/hail-s-jay-olson.html#comment-5278943088) • [8 hours ago](https://www.overcomingbias.com/2021/02/hail-s-jay-olson.html#comment-5279297246)

Normally, this modeling is set up to take advantage of the large-scale homogeneity of the universe -- this scale appears at just above the size of superclusters and voids. That's where the geometry gets really simple.

Within a single galaxy, they would have to appear at \*exactly\* the same time for one not to have an enormous first-mover advantage over the other. And if they did, it may be that small, otherwise-minor differences (in tech used, in location within the galaxy, etc) would also have huge effects on the competitive grab for resources.

But from the outside, from across a cosmological distance and time, this scenario would look just like a single expanding civilization. Geometrically the same as if two or three competing nations initiated aggressive expansion from the same planet, on the same day.

[**Correy Kowall**](https://www.facebook.com/correy.kowall?comment_id=Y29tbWVudDoxMDIyNTc5NjAzMzA3ODUwMF8xMDIyNTc5NjA5NTIwMDA1Mw%3D%3D&__cft__%5B0%5D=AZXKAv9Zq2jEM316jzn2V3fcKm2zTmoVMcC-7a0ssOwMEvXdKrih3lB573sCCkC_bz1WiFXBLLJRKMWMQ966JNw3S3s5-qaxM-NWBq2e39Z4TBiIKR79mPqZRq-OdnBKnXY&__tn__=R%5D-R)

Essentially the same as my Angler Fish hypothesis which is the idea that a post abundance civ uses us to attract predatory civs.

from [IthotItoldja](https://www.reddit.com/user/IthotItoldja) via [/r/GreatFilter](https://www.reddit.com/r/GreatFilter) sent 5 hours ago

I've clashed with you on this before. If the probability "cost" of the universe with 1000 habitable planets is greater than 1000 to 1, we are still more likely to be in the the universe with only one habitable planet. This was the major flaw in your Anthropic Panspermia hypotheses that Robin Hanson himself pointed out to you, but you didn't listen to him! Anyway, no offense meant, you post excellent material here.

I know this. There should be a maximum of a function which multiplies both the number of planets and the "probability cost" - and we are near this maximum. While the number of the planets is straightforward, the cost function needs more guesswork.

[IthotItoldja](https://www.reddit.com/user/IthotItoldja): Right, but as long as the guesswork variable remains unknown, we are no closer to knowing which universe we're in. Zoo hypothesis or not? Panspermia universe or not? The ideas are intriguing and thought-provoking, quite worthwhile to contemplate, but not informative in the slightest until we can dial in the unknown variable(s). Much like the Drake equation. Several of the variables are verified. But as long as even one of them is unknown, we are no closer to knowing the frequency of life occurring.

Me: If the number of habitable planets in one of the cases is like 10 orders magnitude more, it could overweight the uncertainty in the probability distribution.

Moreover, a mathematical simulation - the similar one to the type of simulation which Sandberg and Hanson did – could help to calculate the uncertainty. In this type of simulation they distribute initial parameters randomly and see how often the needed outcome is happening.

For example, if the probability of panspermia is distributed log-normally between 1 and 1:10power20 (so each power has equal chances), and the number of potentially habitable planets is 10power10, than panspermia will be true in half of the cases.

[-][**Stuart\_Armstrong**](https://www.lesswrong.com/users/stuart_armstrong)[5d](https://www.lesswrong.com/posts/xfEsxAtBTLgFe7fSZ/the-sia-population-update-can-be-surprisingly-small?commentId=vwPJvDTkypa9hfivQ)4

Anthropic updates do not increase the probability of life in general; they increase the probability of you existing specifically (which, since you've observed many other humans and heard about a lot more, is roughly the same as the probability of any current human existing), and this might have indirect effects on life in general.

So they does not distinguish between "simple life is very hard, but getting from that to human-level life is very easy" and "simple life is very easy, but getting from that to human-level life is very hard". So panspermia remains at its prior, relative to other theories of the same type (see [here](https://www.lesswrong.com/posts/wgHbNZHsqfiXiqofd/anthropics-and-fermi-grabby-visible-zoo-keeping-and-early#Rare_Earth_hypotheses)).

However, panspermia gets a boost from the universe seeming empty, as some versions of panspermia would make humans unexpectedly early (since panspermia needs more time to get going); this means that these theories avoid the penalty from the universe seeming empty, a much larger effect than the anthropic update (see [here](https://www.lesswrong.com/posts/wgHbNZHsqfiXiqofd/anthropics-and-fermi-grabby-visible-zoo-keeping-and-early#Time_enough_for_aliens)).

My reply: I am still not convinced: it seems that p(abiogenesis) is a very small constant depending on a random generation of a string of around 100 bits.  The probability of life becoming intelligence p(li) is also, I assume, is a constant. The only thing we don't know is a multiplier given by panspermia, which shows how many planets will get "infected" from the Eden in a *given type* of universes. This multiplier, I assume, is different in different universes and depends, say, on the density of stars.  We could use anthropics to suggests that we lives in the universe with the higher values of the panspermia multiplier (depending of the hare of the universes of this type).

The difference here with what you said above is that we don't make any conclusions about the *average global level* of the multiplier over all of the multiverse, you are right that anthropics can't help us here. Here I use anthropics to conclude about what region of the multiverse I am more likely to be located, not to deduce the global properties of the multiverse. Thus there is no SIA, as there is no "possible observers": all observers are real, but some of them are located in more crowded place.

[-][**Stuart\_Armstrong**](https://www.lesswrong.com/users/stuart_armstrong)[3d](https://www.lesswrong.com/posts/xfEsxAtBTLgFe7fSZ/the-sia-population-update-can-be-surprisingly-small?commentId=t6QX28SmuaxahGfnb)4

Nope, that's not the model. Your initial expected population is 1111/4≈278. After the anthropic update, your probabilities of being in the boxes are 1/1111, 10/1111, 100/1111 and 1000/1111 (roughly 0.09%, 0.9%, 9% and 90%). The expected population, however is (11+102+1002+10002)/1111≈909. That's an expected population update of 3.27 times.

Note that, in this instance, the expected population update and the probability update are roughly equivalent, but that need not be the case. Eg if your prior odds are 1:1:10−36 about the population being 1, 1000, or 1012, then the expected population is roughly 500.5, the anthropic-updated odds are 1:1000:10−24, and the updated expected population is roughly 1000. So the probability boost to the larger population is roughly (10−24/1000)/10−36=1021, but the boost to the expected population is roughly 2.