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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 observer selection effects where it could apply, and one is the possibility of *interstellar panspermia* (IP)—meaning that the universes where interstellar panspermia is possible will have a billion times 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. This means that either the Great Filter is ahead for us and there are high risks of anthropogenic extinction, or that there are many alien civilizations hiding nearby—itself a global catastrophic risk.

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

Highlights

- 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, are in the Milky Way Galaxy and are approximately of our age.
- If there is no universal Great filter, alien colonization wave could arrive soon.

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1. Introduction

Serious arguments were recently presented in favor of the Rare Earth hypothesis 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). 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 is Lee 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).

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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

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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.

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.

2.2. 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 10^{500} 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.

3) *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.

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(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. 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

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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 10^{100} 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 10^{80} 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 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

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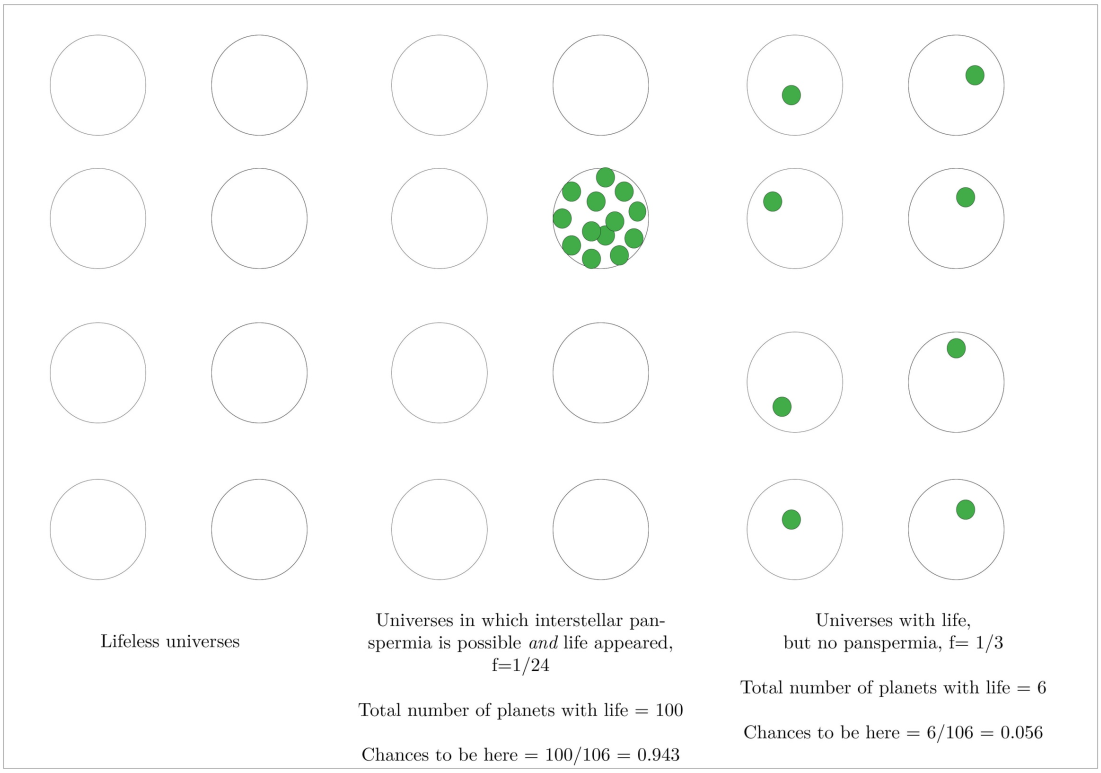
of “observable universes”, that is causally connected regions; our observable universe is just one of such regions. Different bubbles may have different speed of light or size, so they will contain different number of causally connected regions. What we are calculating here is the relation of causally-connected 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 f_{pu} in the multiverse is greater than the frequency of universes with just one habitable planet f_{lu} 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,

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the chance of being in a panspermia universe is:

$$P(PU) = N(pu)/(N(pu)+N(lu)) = mf_{pu}/(mf_{pu} + f_{lu})$$

And it is close to 1 is $f_{lu}/f_{mu} << m$

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. 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-

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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.

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.

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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

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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 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.”

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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

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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 2.1.

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.

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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 affect this distribution, it also proportionally change our chances to be in the panspermia-universe.

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). 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 a few million years, then around 1 million civilizations will appear after the first civilization has already started its process of galactic colonization—and we are likely to be one of them.

If we are one of those civilizations, there is a 1 million to 1 chance 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 will be 1000 times less, and they will appear almost simultaneously. If they appear earlier than the time of colonization, they will start colonization themselves—and they will not be able to appear later, as most planets will be already colonized.

Moreover, 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 assuming there are no colonization effects. 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.

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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.

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, 2019)—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,

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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.

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

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interstellar space colonization. One consequences of this is that their remnant and perhaps dangerous remnants could be eventually found via space exploration (Turchin & Denkenberger, 2019).

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, 2018) – 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).

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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