Great Filter

The **Great Filter**, in the context of the Fermi paradox, is whatever prevents non-living matter from undergoing abiogenesis, in time, to expanding lasting life as measured by the Kardashev scale.[1][2] The concept originates in Robin Hanson's argument that the failure to find any extraterrestrial civilizations in the observable universe implies the possibility something is wrong with one or more of the arguments from various scientific disciplines that the appearance of advanced intelligent life is probable; this observation is conceptualized in terms of a "Great Filter" which acts to reduce the great number of sites where intelligent life might arise to the tiny number of intelligent species with advanced civilizations actually observed (currently just one: human).[3] This probability threshold, which could lie behind us (in our past) or in front of us (in our future), might work as a barrier to the evolution of intelligent life, or as a high probability of self-destruction.[1][4] The main counter-intuitive conclusion of this observation is that the easier it was for life to evolve to our stage, the bleaker our future chances probably are.

The idea was first proposed in an online essay titled "The Great Filter - Are We Almost Past It?", written by economist Robin Hanson. The first version was written in August 1996 and the article was last updated on September 15, 1998. Since that time, Hanson's formulation has received recognition in several published sources discussing the Fermi paradox and its implications.

Using extinct civilizations such as Easter Island as models, a study conducted in 2018 posited that climate change induced by "energy intensive" civilizations may prevent sustainability within such civilizations, thus explaining the lack of evidence for intelligent extraterrestrial life.[5]

Contents

Main argument

Fermi paradox

There is no reliable evidence aliens have visited Earth and we have observed no intelligent extraterrestrial life with current technology nor has SETI found any transmissions from other civilizations. The Universe, apart from the Earth, seems "dead"; Hanson states:[1]

> Our planet and solar system, however, don't look substantially colonized by advanced competitive life from the stars, and neither does anything else we see. To the contrary, we have had great success at explaining the behavior of our planet and solar system, nearby stars, our galaxy, and even other galaxies, via simple "dead" physical processes, rather than the complex purposeful processes of advanced life.

Life is expected to expand to fill all available niches.[6] With technology such as self-replicating spacecraft, these niches would include neighboring star systems and even, on longer time scales which are still small compared to the age of the universe, other galaxies. Hanson notes, "If such advanced life had substantially colonized our planet, we would know it by now."[1]

The Great Filter

With no evidence of intelligent life other than ourselves, it appears that the process of starting with a star and ending with "advanced explosive lasting life" must be unlikely. This implies that at least one step in this process must be improbable. Hanson's list, while incomplete, describes the following nine steps in an "evolutionary path" that results in the colonization of the observable universe:

1. The right star system (including organics and potentially habitable planets)
2. Reproductive molecules (e.g. RNA)
3. Simple (prokaryotic) single-cell life
4. Complex (eukaryotic) single-cell life
5. Sexual reproduction
6. Multi-cell life
7. Tool-using animals with intelligence
8. Where we are now
9. Colonization explosion

According to the Great Filter hypothesis at least one of these steps—if the list were complete—must be improbable. If it's not an early step (i.e., in our past), then the implication is that the improbable step lies in our future and our prospects of reaching step 9 (interstellar colonization) are still bleak. If the past steps are likely, then many civilizations would have developed to the current level of the human species. However, none appear to have made it to step 9, or the Milky Way would be full of colonies. So perhaps step 9 is the unlikely one, and the only things that appear likely to keep us from step 9 are some sort of catastrophe, an underestimation of the impact of procrastination as technology increasingly unburdens existence or resource exhaustion leading to the impossibility of making the step due to consumption of the available resources (like for example highly constrained energy resources).[7] So by this argument, finding multicellular life on Mars (provided it evolved independently) would be bad news, since it would imply steps 2–6 are easy, and hence only 1, 7, 8 or 9 (or some unknown step) could be the big problem.[4]

Although steps 1–8 have occurred on Earth, any one of these may be unlikely. If the first seven steps are necessary preconditions to calculating the likelihood (using the local environment) then an anthropically biased observer can infer nothing about the general probabilities from its (pre-determined) surroundings.

Counterarguments

There are many alternative scenarios that might allow for the evolution of intelligent life to occur multiple times without either catastrophic self-destruction or glaringly visible evidence. These are possible resolutions to the Fermi paradox: "They do exist, but we see no evidence". Other ideas include: it is too expensive to spread physically throughout the galaxy; Earth is purposefully isolated; it is dangerous to communicate and hence civilizations actively hide, among others.

As one example, astronomer Seth Shostak of the SETI Institute argues that one can postulate a galaxy filled with intelligent extraterrestrial civilizations that have failed to colonize the Earth. Perhaps the aliens lacked the intent and purpose to colonize or depleted their resources, or maybe the galaxy *is* colonized but in a heterogeneous manner, or the Earth could be located in a "galactic backwater". Although absence of evidence generally is only weak evidence of absence, the absence of extraterrestrial megascale engineering projects, for example, might point to the Great Filter at work. Does this mean that one of the steps leading to intelligent life is unlikely?[8] According to Shostak:

> This is, of course, a variant on the Fermi paradox: We don't see clues to widespread, large-scale engineering, and consequently we must conclude that we're alone. But the possibly flawed assumption here is when we say that highly visible construction projects are an inevitable outcome of intelligence. It could be that it's the engineering of the small, rather than the large, that is inevitable. This follows from the laws of inertia (smaller machines are faster, and require less energy to function) as well as the speed of light (small computers have faster internal communication). It may be—and

this is, of course, speculation—that advanced societies are building small technology and have little incentive or need to rearrange the stars in their neighborhoods, for instance. They may prefer to build nanobots instead. It should also be kept in mind that, as Arthur C. Clarke said, truly advanced engineering would look like magic to us—or be unrecognizable altogether. By the way, we've only just begun to search for things like Dyson spheres, so we can't really rule them out.[8][9]

See also

- Black swan theory – Theory of response to surprise events
- Doomsday argument – Claims to predict the number of future members of the human species given an estimate of the total number of humans born so far
- Drake equation – Probabilistic argument to estimate the number of alien civilizations in the galaxy
- Anthropic principle – Philosophical consideration that observations of the universe must be compatible with the observers
- Global catastrophic risk – Hypothetical future event that has the potential to damage human well-being on a global scale
- Goldilocks principle – Analogy for optimal conditions
- Inverse gambler's fallacy
- Kardashev scale – A method of measuring a civilization's level of technological advancement, based on the amount of energy a civilization is able to use
- Neocatastrophism – Hypothesis that life-exterminating events such as gamma-ray bursts have acted as a galactic regulation mechanism in the Milky Way upon the emergence of complex life
- Principle of mediocrity
- Rare Earth hypothesis – Hypothesis that complex extraterrestrial life is improbable and extremely rare
- Selection bias – Bias in a statistical analysis due to non-random selection

References

1. Hanson, Robin (1998). "The Great Filter — Are We Almost Past It?" (https://web.archive.org/web/20100507074729/http://hanson.gmu.edu/greatfilter.html). Archived from the original (http://hanson.gmu.edu/greatfilter.html) on 2010-05-07.
2. Overbye, Dennis (August 3, 2015). "The Flip Side of Optimism About Life on Other Planets" (https://www.nytimes.com/2015/08/04/science/space/the-flip-side-of-optimism-about-life-on-other-planets.html). *New York Times*. Retrieved October 29, 2015.
3. Hanson 1998: "No alien civilizations have substantially colonized our solar system or systems nearby. Thus among the billion trillion stars in our past universe, none has reached the level of technology and growth that we may soon reach. This one data point implies that a Great Filter stands between ordinary dead matter and advanced exploding lasting life. And the big question is: How far along this filter are we?"
4. Bostrom, Nick (May–June 2008). "Where Are They? Why I hope the search for extraterrestrial life finds nothing" (http://www.nickbostrom.com/extraterrestrial.pdf) (PDF). *Technology Review*. Massachusetts Institute of Technology: 72–77.
5. Loria, Kevin (June 25, 2018). "There's a compelling explanation for why we've never found aliens—and it could mean humanity is doomed" (http://www.businessinsider.com/climate-change-could-answer-fermi-paradox-2018-6). Business Insider. Retrieved June 25, 2018.
6. "Are We All Alone, or could They be in the Asteroid Belt" by Michael D. Papagiannis, *Quarterly Journal of the Royal Astronomical Society*, Vol. 19, p.277 (http://adsabs.harvard.edu/full/1978QJRAS..19..277P)
7. Baum, Seth (8 February 2010). "Is Humanity Doomed? Insights from Astrobiology". *Sustainability*.
8. Pethokoukis, James M. (2003-11-04). "Keeping His Eyes on the Skies" (https://web.archive.org/web/20130619025348/http://www.usnews.com/usnews/tech/nextnews/archive/next031104.htm). *U.S. News & World Report*. Archived from the original (https://www.usnews.com/usnews/tech/nextnews/archive/next031104.htm) on 2013-06-19.
9. Joseph Voros in "Macro-Perspectives Beyond the World System" (2007) points out that some researchers have attempted to search for energy signatures that could be traced to Dyson-like structures (shells, swarms, or spheres). So far, none have been found. See for example, Tilgner & Heinrichsen, "A Program to Search for Dyson Spheres with the Infrared Space Observatory", *Acta Astronautica* Vol. 42 (May–June, 1998), pp. 607–612; and Timofeev et al. "A search of the IRAS database for evidence of Dyson Spheres", *Acta Astronautica* Vol. 46, (June 2000), pp. 655–659.

Further reading

- Bostrom, Nick (Mar 2002). "Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards" (http://www.jetpress.org/volume9/risks.html). *Journal of Evolution and Technology*. **9**.
- Ćirković, Milan M.; Vesna Milosevic-Zdjelar (2003). "Extraterrestrial Intelligence and Doomsday: A Critical Assessment of the No-Outsider Requirement" (http://saj.matf.bg.ac.rs/166/pdf/01-11.pdf) (PDF). *Serbian Astronomical Journal* (166): 1–11. doi:10.2298/saj0366001c (https://doi.org/10.2298%2Fsaj0366001c).
- Ćirković, Milan M. (2004-08-27). "Permanence - An Adaptationist Solution to Fermi's Paradox?". arXiv:astro-ph/0408521 (https://arxiv.org/abs/astro-ph/0408521).
- Ćirković, Milan M.; Robert J. Bradbury (Jul 2006). "Galactic Gradients, Postbiological Evolution and the Apparent Failure of SETI". *New Astronomy*. **11** (8): 628–639. arXiv:astro-ph/0506110 (https://arxiv.org/abs/astro-ph/0506110). Bibcode:2006NewA...11..628C (https://ui.adsabs.harvard.edu/abs/2006NewA...11..628C). doi:10.1016/j.newast.2006.04.003 (https://doi.org/10.1016%2Fj.newast.2006.04.003).
- Ćirković, Milan M. (Jul 2008). "Against the Empire". *Journal of the British Interplanetary Society*. **61**: 246–254. arXiv:0805.1821 (https://arxiv.org/abs/0805.1821). Bibcode:2008JBIS...61..246C (https://ui.adsabs.harvard.edu/abs/2008JBIS...61..246C).
- Ćirković, Milan M. (2008). "Observation selection effects and global catastrophic risks". In Nick Bostrom,Milan M. Ćirković (eds.). *Global Catastrophic Risks*. Oxford University Press.
- Dvorsky, George (2007-08-04). "The Fermi Paradox: Back with a vengeance" (http://www.sentientdevelopments.com/2007/08/fermi-paradox-back-with-vengeance.html). Sentient Developments.
- Hanlon, Michael (2008). *Eternity: Our Next Billion Years*. Palgrave Macmillan. ISBN 0-230-21931-4.

External links

- The Great Filter - Are We Almost Past It? (http://mason.gmu.edu/~rhanson/greatfilter.html), Robin Hanson, 1998
