

Are you an Alien Organization? Dare to take the test!

In addition to its main purpose of publishing experimental innovation research related results, CIJ also publishes lighter, inspirational food-for-thought intended "IdeaSquare Coffee Papers". These pieces are collaborative efforts prepared by researchers from various walks of life visiting or staying at the CERN IdeaSquare premises. The identity of the contributing authors is kept anonymous (although known) but helpful hints can be found in the literature references. Editors of this section are Dr. Markus Nordberg and Dr. Valeria Brancolini.

EXECUTIVE SUMMARY

Did you think the IdeaSquare innovation team has run out of things to think about? If so, you are wrong because this time the team explores alien civilizations!

INTRODUCTION

“Look again at that dot. That's here. That's home. That's us. On it, everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there--on a mote of dust suspended in a sunbeam.”

Carl Sagan, Pale Blue Dot: A Vision of the Human Future in Space.

ALIENS: OUR OLD FRIENDS

Alien Civilizations have been a source of inspiration for human imagination for ages. For example, the 2nd century Assyrian writer of satires, Lucian of Samosata¹, in his *True History*, claims having visited the Moon when his ship was sent up by a whirlwind. The Moon, according to him, was inhabited by beings at war against the ones from the Sun over the colonisation of the Morning Star. Other early imaginative accounts of alien civilizations can be found, for example, in the 10th-century Japanese narrative, *The Tale of the Bamboo Cutter*², and the medieval Arabic, *The Adventures of Bulukiya* (within the novel *One Thousand and One Nights*³).

Even respected physicists have not been foreign to the impulse of imagining alien civilizations. For example, the great Johannes Kepler's narration *Somnium*⁴, published in 1634, depicts a character, *Duracotus*, that is transported to the Moon by demons (Fig. 1).

¹ <https://en.wikipedia.org/wiki/Lucian>

² https://en.wikipedia.org/wiki/The_Tale_of_the_Bamboo_Cutter

³ https://en.wikipedia.org/wiki/One_Thousand_and_One_Nights#Fantasy_and_science_fiction_elements

⁴ https://en.wikipedia.org/wiki/Johannes_Kepler and [https://en.wikipedia.org/wiki/Somnium_\(novel\)](https://en.wikipedia.org/wiki/Somnium_(novel))

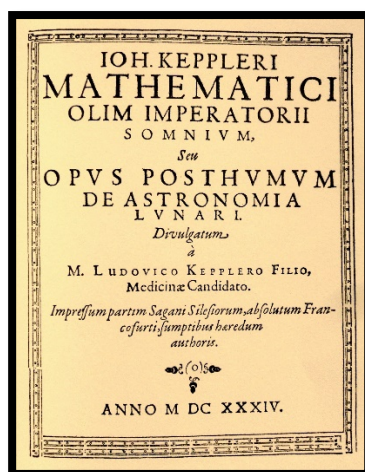


Fig. 1. Front page of Kepler's science fiction book *Somnium*. Source: [https://en.wikipedia.org/wiki/Somnium_\(novel\)](https://en.wikipedia.org/wiki/Somnium_(novel))

Of course, the main elements of any alien civilization are aliens themselves. Strictly speaking, an extra-terrestrial or alien is any lifeform that did not originate on Earth. The first published use of extra-terrestrial as a noun occurred in 1956, during the so called, by US scholars, *Golden Age of Science Fiction*⁵. It covers the period from 1938 to 1946 and it's characterised by the fact that the science fiction genre gained wide public attention due to the explosion of stories published in proliferating magazines. As an additional historical note for the reader, the Golden Age follows the "*Pulp Era*" of the 1920s and 1930s and precedes the *New Wave Science Fiction* of the 1960s and 1970s⁶.

Probably, this *extra-terrestrial booming* inspired the physicists formulating themselves three natural questions:

- Do aliens exist?
- If so, where are they?
- If so, can we both communicate?

As it is obvious, answering the third question will answer automatically the other two. Therefore, the physicists got hands-on imagining what kind of technology would allow exploring signals from an alien civilization capable of sending them. Since detection and imaging technologies such as radio telescopes were already used incipiently for scanning the Cosmos, the most natural way was considering this possibility⁷.

LET THERE BE SETI!

In the March 1955 issue of *Scientific American*⁸, John D. Kraus⁹, an American physicist known for his contributions to electromagnetics, radio astronomy, and antenna theory, described an idea to scan the Cosmos for natural radio signals using a flat-plane radio telescope equipped with a parabolic reflector¹⁰. Two years later, his concept was approved for construction by Ohio State University. A total of US\$71,000 in grants from the *National Science Foundation*¹¹ helped, so the construction began on an 8-hectare plot in Delaware, Ohio. As original as physicists are for naming, this first Radio

⁵ https://en.wikipedia.org/wiki/Golden_Age_of_Science_Fiction

⁶ https://en.wikipedia.org/wiki/History_of_US_science_fiction_and_fantasy_magazines_to_1950 and https://en.wikipedia.org/wiki/New_Wave_science_fiction

⁷ https://en.wikipedia.org/wiki/Radio_telescope

⁸ https://en.wikipedia.org/wiki/Scientific_American, John D. Kraus, Radio Telescopes, Volume 192, Number 3, March, 195: 36–43.

⁹ https://en.wikipedia.org/wiki/John_D._Kraus

¹⁰ He was also contributing to construct and operate the University of Michigan 100-ton cyclotron, the world's most powerful particle accelerator at that time...please do not consider this fact as a demonstration of how apparently crazy particle physicists are combining hobbies such as alien searching with their "normal job".

¹¹ https://en.wikipedia.org/wiki/National_Science_Foundation once more, clear evidence that only public funding can support especially adventurous enterprises. Thank God, public funding exists!!!

Observatory telescope was called "*Big Ear*". Later, it began the world's first continuous SETI program, called the Ohio State University *SETI* program (Search for Extra-Terrestrial Intelligence)¹².

Let's move now to 1960 because the first hero of this coffee paper (bear with us, please), Cornell University astronomer Frank Drake¹³, performed the first modern SETI experiment intended to look for extra-terrestrial communication radio signals: "*Project Ozma*"¹⁴. The name was given after *Princess Ozma*, ruler of the Land of Oz. It was inspired by L. Frank Baum's imaginary communications with Oz by radio, for learning about the events recalled in his books. The search grabbed the attention of media such as *Time* magazine but unfortunately, nothing of interest was found¹⁵. Soviet scientists also took a strong interest in searching extra-terrestrial signals during the 1960s performing a number of searches with omnidirectional antennas in the hope of picking up any also with negative results. The excitement nevertheless did not decay and the Soviet astronomer Iosif Shklovsky¹⁶ wrote the pioneering book in the field, *Universe, Life, Intelligence* (1962), which the American astronomer Carl Sagan¹⁷ expanded as the best-selling book *Intelligent Life in the Universe* (1966).

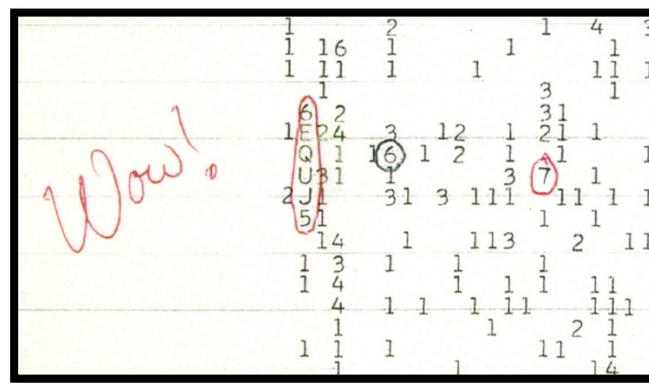


Fig. 2. The original printout with Jerry Ehman's handwritten exclamation of The Wow! Signal represented as "6EQUJ5". Source: https://en.wikipedia.org/wiki/Wow!_signal

An especially popular moment for the Ohio State SETI program occurred on August 15th, 1977, when Jerry Ehman, a project volunteer, witnessed a startlingly strong signal received by the telescope. He quickly circled the indication on a printout and scribbled the exclamation "*Wow!*" in the margin (Fig. 2)¹⁸. Dubbed the *Wow! signal*, it is considered by some to be the best candidate for a radio signal from an artificial, extra-terrestrial source ever discovered, but it has not been detected again in several additional searches and its origin and explanation remains unclear¹⁹.

Despite subsequent attempts to find alien signals, nothing continued to be found. Therefore, some physicists went back to the drawing board asking another type of question. Not concluding yet on the existence or lack of aliens, the question was:

- How many are there advanced enough for sending signals?

This is where our first hero, Frank Drake, enters the scene.

¹² <https://www.seti.org/>

¹³ https://en.wikipedia.org/wiki/Frank_Drake

¹⁴ https://en.wikipedia.org/wiki/Project_Ozma

¹⁵ <http://content.time.com/time/subscriber/article/0,33009,874057,00.html>

¹⁶ https://en.wikipedia.org/wiki/Iosif_Shklovsky

¹⁷ https://en.wikipedia.org/wiki/Carl_Sagan

¹⁸ https://en.wikipedia.org/wiki/Wow!_signal

¹⁹Paul H. Shuch, (ed.), 2011, *Searching for Extra-Terrestrial Intelligence: SETI Past, Present, and Future*. Springer, Berlin, Germany.

MR. FRANK(CIS) DRAKE EQUATION

The Drake equation is a probabilistic argument used to estimate the number of possible extra-terrestrial civilizations in the Milky Way capable of sending signals. To be fair with Mr. Drake, we must mention that he originally wrote his 1961 equation not with the purpose of quantifying the number of alien civilizations, but as a way of stimulating scientific dialogue at the first meeting for the search for extra-terrestrial intelligence²⁰. The equation summarizes the main variables to be considered when pondering the question of other radio-communicative life. It is an approximation pathway rather than a rigorous attempt for determining a precise number. The equation nevertheless is beautiful and very simple to understand²¹:

$$N = R_* f_p n_e f_l f_i f_c L$$

The meaning of the different symbols used goes as follows:

N = the number of civilizations in our galaxy with which (radio) communication might be possible.

R_* = the average rate of star formation in our galaxy.

f_p = the fraction of those stars that have planets.

n_e = the average number of planets that can potentially support life per star that has planets.

f_l = the fraction of planets that could support life that actually develop such life at some point.

f_i = the fraction of planets with life that actually go on to develop intelligent life (civilizations).

f_c = the fraction of civilizations that develop a technology that releases detectable signals of their existence into space.

L = the length of time for which such civilizations release detectable signals into space.

It is beyond this coffee paper to offer a detailed account of how scientists estimate the different parameters, but we offer a fascinating bibliography, which we encourage the interested reader to check.



Fig. 3. The Drake Equation plaque mounted above the fireplace in the conference room/library of the residence hall of the National Radio Astronomy Observatory in Green Bank, West Virginia. It depicts the Drake's equation commemorating the first SETI meeting (see footnote 20). Source: <https://www.astronomynotes.com/telescope/greenbanktour/gbtour12.htm>

²⁰ As usual with great enterprises, one must start with the coalition of the willing. Thus, the first scientific meeting on the search for extra-terrestrial intelligence had 10 attendees. Those were the conference organizer J. Peter Pearman (a staffer for the National Academy of Sciences' Space Science Board), Frank Drake (astronomer), Philip Morrison (businessman and radio amateur), Dana Atchley (chemist), Melvin Calvin, (astronomer), Su-Shu Huang (neuroscientist), John C. Lilly (inventor), Barney Oliver (astronomer), Carl Sagan (physicist) and Otto Struve (radio astronomer). They dubbed themselves "*The Order of the Dolphin*" (because of Lilly's work on dolphin communication) and commemorated their first meeting with a plaque at the National Radio Astronomy Observatory, Green Bank in Green Bank, West Virginia Hall. <https://www.discovermagazine.com/the-sciences/the-secret-origins-of-the-search-for-extraterrestrial-intelligence>. There are no records of any other substances consumed besides Drake's equations for animating the discussions.

²¹ Exactly the type of equation that fits in a T-shirt and is cool to be seen with but that hides a big mystery, which is the standard set by the IdeaSquare innovation team of significant equations in the history of science. Planck's energy-frequency formula and Einstein's mass-energy equivalence among others are equal examples.

Nevertheless, we mention that both “optimists” and “pessimists” scientists have used the Drake’s equation with, of course, wildly differing results²². The participants of the first SETI meeting concluded that roughly $N \cong L$, meaning that there are probably between 1000 and 100,000,000 civilizations in the Milky Way galaxy. The values they used were:

- $R_* = 1 \text{ yr}^{-1}$ (1 star formed per year, on the average over the life of the galaxy; this was regarded as conservative).
- $f_p = 0.2$ to 0.5 (one fifth to one half of all stars formed will have planets).
- $n_c = 1$ to 5 (stars with planets will have between 1 and 5 planets capable of developing life).
- $f_l = 1$ (100% of these planets will develop life).
- $f_i = 1$ (100% of which will develop intelligent life).
- $f_c = 0.1$ to 0.2 (10–20% of which will be able to communicate).
- $L = 1000$ to $100,000,000$ years (which will last somewhere between 1000 and 100,000,000 years)

Inserting the above minimum numbers into the equation gives a minimum N of 20 while the maximum numbers give 50,000,000. Thus, and considering the uncertainties in the values, the first SETI meeting concluded as we mentioned.

On the other hand, physicists like Frank Tipler and John D. Barrow used pessimistic numbers and speculated that the average number of civilizations in a galaxy is much less than one²³.

The physicists Anders Sandberg, Eric Drexler and Toby Ord, have carried out an analysis taking into account the different uncertainties in all the Drake’s equations variables suggesting that, with very high probability, either intelligent civilizations are plentiful in our galaxy or humanity is alone in the observable universe²⁴. The lack of observation of intelligent civilizations until now, they claim, points towards the latter option. This type of reasoning leads us to the second hero of our story: the physicist Mr. Enrico Fermi²⁵.

MR. FERMI AND ALL THE MISSING LUNCH GUESTS

The Fermi Paradox, named after the physicist Enrico Fermi, shows the apparent contradiction between the lack of evidence for extra-terrestrial civilizations and various optimistic estimates for their probability for the Drake equation²⁶.

Although he was not the first considering this question²⁷, Fermi’s name is associated with the paradox because of a casual conversation during the summer of 1950 with fellow physicists Edward Teller, Herbert York and Emil Konopinski²⁸. As the legend goes, while walking to lunch, they were discussing about recent UFO reports and the possibility of faster-than-light travel. The conversation moved on to other topics, but when Fermi, during lunch, allegedly suddenly said, “*But where is everybody?*”, all understood that he was referring to the apparent absence of aliens²⁹.

²² https://en.wikipedia.org/wiki/Drake_equation and bibliography at the end of this paper.

²³ John D. Barrow and Frank J. Tipler, 1998, *The Anthropic Cosmological Principle*. Oxford University Press, Oxford, UK.

²⁴ Anders Sandberg, Eric Drexler, Toby Ord, 2018, *Dissolving the Fermi Paradox*, <https://arxiv.org/abs/1806.02404>

²⁵ Please excuse us, but we continue to insist on the lack of a causal relationship between being a particle physicist and the “hobby” of searching for alien life in the Universe.

²⁶ https://en.wikipedia.org/wiki/Enrico_Fermi and https://en.wikipedia.org/wiki/Fermi_paradox

²⁷ Konstantin Tsiolkovsky, a Russian rocket scientist and pioneer of the astronautic theory, made an earlier implicit mention in an unpublished manuscript from 1933, titled *The Planets are Occupied by Living Beings*, kept in the Archives of the Tsiolkovsky State Museum of the History of Cosmonautics, Kaluga, Russia. He noted: “*people deny the presence of intelligent beings on the planets of the universe*” because “(i) if such beings existed, they would have visited Earth, and (ii) if such civilizations existed then they would have given us some sign of their existence.”

²⁸ Herbert York and Emil Konopinski were both nuclear physicists and Edward Teller’s name is closely related to particle physics as well, but we insist, once again: there is no causal relationship between being a particle physicist and the search for alien life. Please do not even think that since we cited Johannes Kepler before it is the exception that confirms the rule. We carefully decided not to comment here on causal relationships for faster than light travelling discussions and particle physics.

²⁹ “Where is everybody?": An account of Fermi’s question”, Dr. Eric M. Jones, Los Alamos technical report, March 1985. <https://fas.org/sgp/othergov/doe/lanl/la-10311-ms.pdf>

In 1975, another physicist, Michael H. Hart³⁰, published a detailed examination of the paradox, which has since become a theoretical reference point for much of the research into what is better known as the Fermi–Hart paradox³¹. Hart’s frame for Fermi’s paradox is as follows:

- There are billions of stars in the Milky Way similar to the Sun.
- With high probability, some of these stars have Earth-like planets and if the Earth is a typical planet, some may have already developed intelligent life.
- Some of these civilizations may have developed interstellar travel since we are ourselves investigating it now.
- Even at the slow pace of current interstellar travel possibilities, the Milky Way could be completely traversed in a few million years.
- And since many of the stars similar to the Sun are billions of years older, this would seem to provide plenty of time for these alien civilizations to contact us.

Thus, according to this line of reasoning, an extra-terrestrial civilization or at least their probes, should have already visited the Earth. Nevertheless, despite many efforts, nothing has been detected so far. Thus, Fermi’s paradox remains unexplained. There have been many attempts to explain it, primarily suggesting that intelligent extra-terrestrial beings are extremely rare, that the lifetime of such civilizations is short, or that they exist but (for various reasons) we see no evidence³².

PERHAPS NO ALIEN CIVILIZATIONS BUT MAYBE...ALIEN ORGANIZATIONS?

Following the finest tradition (although no causal connection exists as we insist once more) of particle physicists involved in the search for alien civilizations, the IdeaSquare’s innovation team has embarked in the mission of finding Alien Organizations on Planet Earth in the context of innovation³³. For that, we have developed a self-test kit that includes two definitions, a simple formula and easy test instructions for those organizations willing to help us in our search.

Definitions

IdeaSquare’s innovation team definition for an Alien Organization, in the context of innovation, is:

Alien Organization: Anyone that, in the course of its existence, has been able to produce transformative innovation(s). By transformative innovation, we mean one capable of changing the paradigms of society globally. Examples can be:

***The wheel:** it changed the paradigm of transportation.*

***The steam engine:** it changed many paradigms, among them, industrial production, transport, etc.*

***The internet:** it changed the paradigm of connectivity.*

***The WWW:** it changed the paradigm of communication.*

***The transistor (and integrated circuit):** it changed the paradigm of the technology for communication.*

***The personal computer:** It changed the paradigm of information processing.*

***3D printing:** It changed the paradigm of manufacturing.*

Formula

Since, as seen by the definition above, Alien Organizations are linked to transformative innovation, also as defined, as a second step and emulating Frank Drake, the IdeaSquare innovation team postulates the following equation and parameters:

$$N = R_* f_o n_j f_b f_i f_d L$$

³⁰ We hope you appreciate, given our comment above, that he was an astrophysicist.

³¹ Hart, Michael H., 1975, Explanation for the Absence of Extra-terrestrials on Earth, Quarterly Journal of the Royal Astronomical Society. 16: 128–135.

³² See the bibliography provided at the end of this paper.

³³ As we strictly follow a scientific approach here, it is left to the imagination of the reader to consider whether the IdeaSquare team has been recently re-visiting “Men in Black” as a source of inspiration.

- N = the number of transformative innovations generated by your organization until now.
- R_* = the average rate/year of ideas your organization generates.
- f_o = the fraction of those ideas that are qualified as “out of the box”. Meaning non- incremental or in other words, “business as usual”.
- n_j = the average number of non-incremental ideas that are surviving “clever judgement”. It means, the ones surviving the test: “It is nice but...”
- f_b = the fraction of non-incremental ideas, surviving clever judgement that survive your bureaucracy. Meaning, those one surviving: “It is nice, let’s do it but hierarchy will not allow us, so forget it...”
- f_i = the fraction of non-incremental ideas, surviving clever judgement, surviving your bureaucracy that also count with implementation resources.
- f_a = the fraction of non-incremental ideas, surviving clever judgement, surviving your bureaucracy, counting with implementation resources and that are open to be discussed with others³⁴.
- L = the length of time in years for non-incremental ideas, surviving clever judgement, surviving your bureaucracy, counting with implementation resources and that are open to be discussed with others are patiently incubated to decide go/no go based on facts.

Test Instructions

The test relies on the principle of the “wisdom of the crowds” ensuring the necessary diversity of opinions for obtaining the best results³⁵. Therefore, the IdeaSquare innovation team advises:

- Ask everyone in your organization for an estimation of N in the formula. Each one must calculate it individually and without communication between each other(s). For even better results, ask your customers or any other stakeholders dealing closely with your organization to fill it as well.
- Average all the results obtained and normalise this average to a 1 to 10 scale. If the average is not an integer, take the closest integer to your average. The final number is your score.
- Look up to the results in the following table.

Score	Evaluation Comments elaborated by the IdeaSquare innovation team
1 to 3	Congratulations! You are a truly Alien Organization. Please keep it up.
4 to 5	We are not sure you are an Alien Organization, but definitely, you have some aliens working and specially filling tests.
6 to 8	Are you sure you understood the definition of transformative innovation?
8 to 10	Congratulations! You may not be an Alien Organization, but your employees are well trained in filling tests. Greetings to your HR and PR Departments.

- Please submit your results to IdeaSquare_lookingforaliens@milkyway.com and we will be grateful for your contribution to our research.

Of course, the IdeaSquare team did make detailed calculations as to how many Alien Organizations there are on Planet Earth. To avoid embarrassing too many, including our peers, we shall leave the results outside the scope of this paper for a future time. We are thinking of naming it “The Self-Complacency Paradox”. Truly originally, the first lines start something like this:

In a world where everyone claims to be disruptive, the number of paradigm changing innovations are nevertheless scarce....so: Where is everyone?

To be continued...or not... or maybe by aliens.

Cheers.

³⁴ This parameter reflects your organization “Open Innovation” degree.

³⁵ https://en.wikipedia.org/wiki/Wisdom_of_the_crowd

ALIEN BIBLIOGRAPHY

Besides the references offered along the paper, the IdeaSquare innovation team recommends among others:

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Paul Davies, 2010, *The Eerie Silence*, Houghton Mifflin Harcourt, Boston, Massachusetts.

The SETI Institute <https://www.seti.org/>

SETI@home, <https://setiathome.berkeley.edu/>. SETI@home is a scientific experiment, based at UC Berkeley, using Internet-connected computers in the Search for Extra-Terrestrial Intelligence (SETI). You can participate by running a free program that downloads and analyses radio telescope data.