

Should We Answer?

SETI, the Fermi Paradox, and the Risk of Saying Hello

Humans & The Universe — Lesson 2 of 8

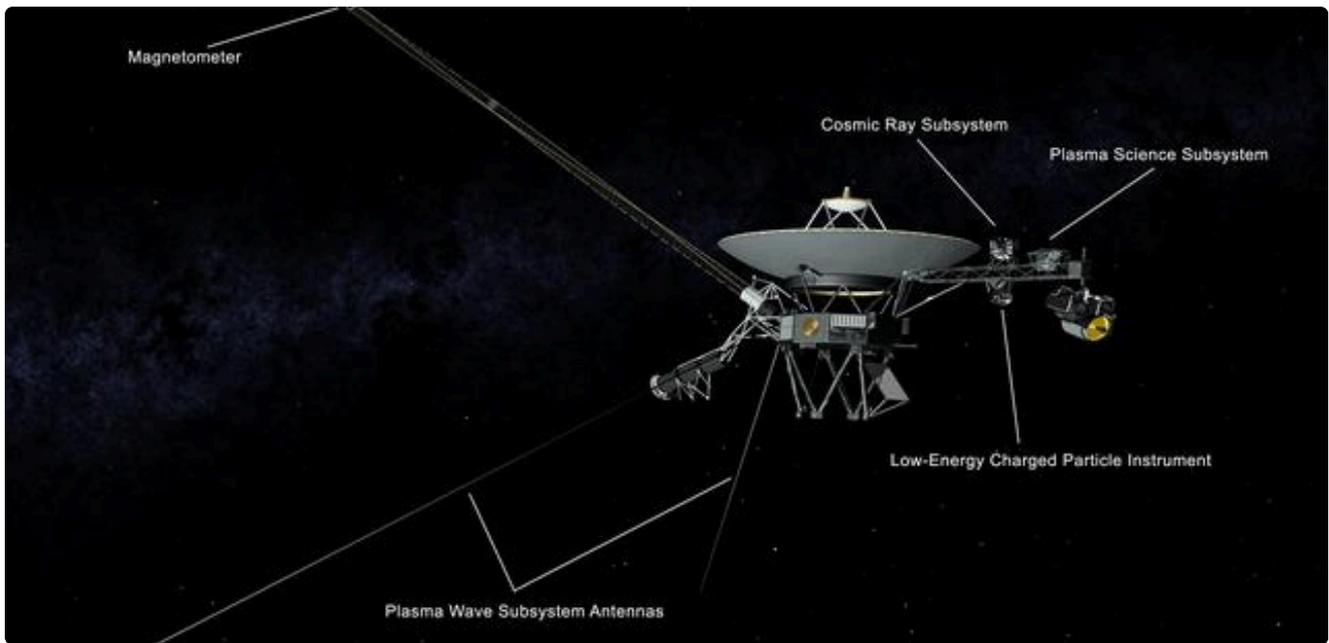


Radio telescopes like these scan the sky for signals from other civilizations

PART 1: THE GREAT SILENCE

The universe is approximately 13.8 billion years old and contains an estimated two trillion galaxies. Our Milky Way alone holds between 100 and 400 billion stars, many of which have planets. Given these staggering numbers, the Italian physicist Enrico Fermi asked a simple question over lunch in 1950: "*Where is everybody?*" If intelligent life should be common in a universe this vast and this old, why have we found no evidence of it? This question became known as the **Fermi Paradox**.

The silence is deafening. Since 1960, the **Search for Extraterrestrial Intelligence (SETI)** has used radio telescopes to scan the sky for artificial signals — patterns that could not be produced by natural phenomena. In over six decades of listening, we have detected almost nothing. The one exception is the famous **Wow! Signal** of 1977: a powerful, narrowband radio signal detected by Ohio State University's Big Ear telescope. Astronomer Jerry Ehman circled it on the printout and wrote "Wow!" in the margin. The signal lasted 72 seconds, matched the expected profile of an **extraterrestrial** transmission, and has never been detected again.



NASA's Voyager 1, now over 24 billion km from Earth, carries a Golden Record with messages for alien civilizations

PART 2: ACTIVE SETI — SHOULD WE SHOUT?

Listening is one thing. But some scientists want to go further: they want to **transmit** messages into space, actively announcing humanity's existence. This is called **Active SETI** or **METI** (Messaging Extraterrestrial Intelligence). In 1974, the **Arecibo Message** was beamed toward a star cluster 25,000 light-years away. It contained basic information about our solar system, DNA structure, and a stick figure of a human being. NASA's Voyager spacecraft carry **Golden Records** — gold-plated discs containing sounds, music, and images from Earth, including greetings in 55 languages.

But not everyone thinks broadcasting is wise. The physicist Stephen Hawking warned: *"If aliens visit us, the outcome would be much as when Columbus landed in America, which didn't turn out well for the Native Americans."* Critics of Active SETI argue that we are essentially lighting a fire in the dark forest — attracting attention from unknown entities whose intentions we cannot predict. The **Dark Forest Theory** from Lesson 1 suggests this could be suicidal.

"The history of contact between civilizations with unequal technology is not encouraging. In virtually every case, the more advanced civilization has destroyed or absorbed the less advanced one."

— Jared Diamond, *The Third Chimpanzee*

PART 3: THE DRAKE EQUATION

In 1961, astronomer Frank Drake created a formula to estimate the number of detectable civilizations in our galaxy. The **Drake Equation** multiplies several factors together: the rate of star formation, the fraction of stars with planets, the fraction of those planets that could support life, the

fraction where life actually develops, the fraction that becomes intelligent, the fraction that develops **detectable** technology, and the length of time such civilizations broadcast signals.

The problem is that most of these values are unknown. Depending on your assumptions, the equation can produce anywhere from zero (we are alone) to millions of civilizations. The most uncertain variable is the last one — how long civilizations survive. If most civilizations destroy themselves through war, environmental collapse, or reckless technology within a few centuries of developing radio, the galaxy could be full of dead worlds. The silence of the cosmos might not mean life is rare — it might mean **intelligent life doesn't last**.

The Drake Equation

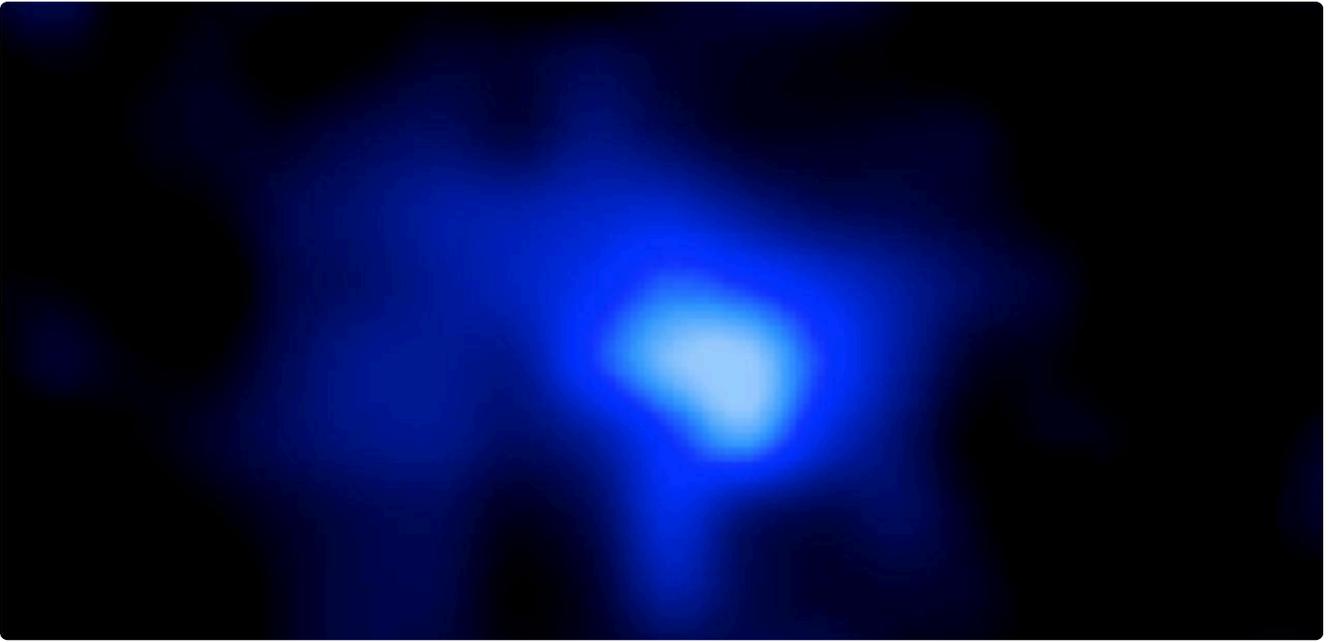
$$N = R^* \times fp \times ne \times fl \times fi \times fc \times L$$

Where N = number of detectable civilizations, R* = rate of star formation, fp = fraction with planets, ne = habitable planets per star, fl = fraction where life develops, fi = fraction that becomes intelligent, fc = fraction that communicates, L = how long they survive

PART 4: FERMI PARADOX SOLUTIONS

Scientists have proposed dozens of solutions to the Fermi Paradox. The **Great Filter** theory suggests there is some barrier — some step in evolution — that is extremely difficult to pass. If the filter is behind us (such as the development of complex cells), then we are lucky survivors and the universe is mostly empty. If the filter is ahead of us (perhaps the development of powerful technology inevitably leads to self-destruction), then our future is dark.

Other solutions are equally unsettling. The **Zoo Hypothesis** suggests advanced aliens know we exist but deliberately avoid contact — like wildlife researchers observing animals without **interfering**. The **Planetarium Hypothesis** goes further: perhaps our entire observable universe is a simulation created by an advanced civilization. And then there is the simplest, most humbling answer of all: perhaps we are looking in the wrong place, at the wrong time, using the wrong technology. The universe is vast, and we have only been listening for sixty years. In cosmic terms, that is less than a blink.



The observable universe contains two trillion galaxies — are we really alone?

KEY VOCABULARY

Fermi Paradox — the contradiction between the high probability of alien life and the lack of evidence

extraterrestrial — originating from outside Earth

SETI — Search for Extraterrestrial Intelligence; the scientific effort to detect alien signals

transmit — to send a signal or message outward

Active SETI / METI — deliberately sending messages into space

detectable — able to be discovered or noticed

Drake Equation — a formula estimating the number of communicating civilizations

Great Filter — a theoretical barrier that prevents civilizations from becoming widespread

Zoo Hypothesis — the idea that aliens observe us but don't interfere

narrowband — a signal concentrated in a very specific frequency range (unlikely to be natural)

interfering — getting involved in something in a way that disrupts it

phenomena — observable events or occurrences (plural of phenomenon)

staggering — so large or surprising as to be shocking

reckless — acting without thinking about the consequences

A. COMPREHENSION

1. What is the Fermi Paradox? State it in your own words.
2. What was the Wow! Signal? Why was it significant?
3. What is the difference between SETI and Active SETI (METI)?
4. Why did Stephen Hawking compare alien contact to Columbus arriving in America?
5. What is the "Great Filter" and why does it matter whether it's behind us or ahead of us?
6. Name two other solutions to the Fermi Paradox discussed in the reading.
7. According to the reading, what might the silence of the cosmos tell us about intelligent life?

B. VOCABULARY IN CONTEXT

Complete each sentence with a word from the vocabulary list:

1. The telescope detected a _____ radio signal that couldn't have come from a natural source.
2. The _____ between the size of the universe and the absence of alien evidence puzzles scientists.
3. Some researchers want to actively _____ messages into deep space, hoping someone will hear.
4. The number of galaxies in the observable universe is _____ — over two trillion.
5. Critics call Active SETI _____ because we don't know who might receive our signals.

6. The _____ suggests aliens might be watching us like scientists observe animals in nature.

7. If the _____ is ahead of us, it means most civilizations destroy themselves before spreading across space.

C. CRITICAL THINKING

1. If you could add one item to the Voyager Golden Record to represent humanity, what would you include and why?

2. The Drake Equation requires estimating values we don't know. Does this make it useful or useless? What's the value of a formula when most inputs are guesses?

3. Compare the Zoo Hypothesis with the Dark Forest Theory (Lesson 1). How are they similar? How are they different? Which do you find more convincing?

4. The reading suggests intelligent life might not last long. Look at human civilization — do you think we are at risk of self-destruction? What are our biggest threats?

D. THE GREAT DEBATE: SHOULD HUMANITY BROADCAST?

Scenario: The United Nations has discovered a radio signal from a star system 40 light-years away. It appears artificial but contains no message — just a repeating pattern. A committee must decide: *Should we send a reply?*

Position A: Yes, send a reply.

Silence is cowardice. We've been leaking radio waves for a century — they already know we're here. A deliberate message shows intelligence and good faith. The potential benefits of contact (knowledge, technology, partnership) far outweigh the risks. Hiding is not a strategy — it's fear.

Position B: No, stay silent.

We know nothing about them. Every historical example of unequal contact ended badly for the weaker side. A 40-light-year distance means an 80-year round trip for messages — we can't negotiate, only announce ourselves. The risk is existential. Silence costs nothing; a reply could cost everything.

Position C: Reply, but carefully.

Send a response, but reveal as little as possible. Acknowledge the signal without providing our exact location, population, or technology level. Test their response before sharing more. Diplomacy, not disclosure.

E. DESIGN ACTIVITY: MESSAGE TO THE STARS

Your task: Design a message to send to an alien civilization. You cannot use any human language — they won't understand it. You have a radio signal that can encode images, sounds, and mathematical patterns.

Consider:

- What information is safe to share? What should you hide?
- How do you communicate without shared language? (Think: math, music, images)
- What impression of humanity do you want to create?
- The Arecibo Message used binary code to create simple images. What would you encode?

Present your design to your teacher and defend your choices.

F. FERMI PARADOX SOLUTIONS — RANK & DISCUSS

Rank these Fermi Paradox solutions from most to least convincing. Discuss your ranking with your teacher.

1. The Great Filter

Some evolutionary step is nearly impossible to pass. Most civilizations never make it.

2. The Dark Forest

Everyone is hiding because revealing yourself is fatal.

3. The Zoo Hypothesis

Advanced aliens are watching us but won't make contact.

5. Wrong Technology

Aliens don't use radio. We're listening for the wrong thing.

4. We're Too Early

The universe is young. We might be among the first intelligent species.

6. Self-Destruction

All civilizations destroy themselves before becoming interstellar.



Earthrise — photographed during Apollo 8, 1968. Our only known home in the universe.

Teacher's Notes & Answer Key

Should We Answer? — Instructor Guide

LESSON OVERVIEW

Level: Advanced (B2-C1) | **Duration:** 60–90 minutes | **Focus:** Reading, debate, creative problem-solving
Series: Humans & The Universe, Lesson 2 of 8 | **Prerequisite:** Lesson 1 recommended but not required

SUGGESTED LESSON FLOW

Warm-up (5 min): "If aliens sent us a message tomorrow, what would you want it to say?" Open discussion.

Pre-reading (5 min): Review key vocabulary. Focus on: Fermi Paradox, extraterrestrial, transmit, Great Filter.

Reading (15-20 min): Parts 1-4. Can split: student reads Parts 1-2, teacher summarizes 3-4 (or vice versa).

Comprehension (10 min): Section A. Quick oral check or written.

Vocabulary (10 min): Section B fill-in-blanks.

Debate (15-20 min): Section D — three positions. Teacher takes opposing view. Push for evidence-based reasoning.

Creative Activity (15-20 min): Section E — design a message. This works especially well for analytical/engineering-minded students.

Ranking (5-10 min): Section F — quick ranking discussion as cool-down.

ANSWER KEY — SECTION A

1. The universe is very old and very large, so intelligent life should be common — but we've found no evidence of it. The contradiction between expectation and reality is the paradox.
2. A powerful, narrowband radio signal detected in 1977 that matched the expected profile of an artificial extraterrestrial transmission. It lasted 72 seconds and was never detected again. Significant because it's the closest thing to evidence of alien communication.
3. SETI = passively listening for signals from space. Active SETI/METI = deliberately transmitting messages outward, announcing our existence.
4. Because historically, when a more advanced civilization meets a less advanced one, the outcome is devastating for the weaker side. Alien contact could follow the same pattern.
5. A theoretical barrier that's extremely hard for civilizations to pass. If behind us = we're rare survivors (good). If ahead = civilizations typically self-destruct before becoming interstellar (very bad for us).
6. Zoo Hypothesis (aliens observe but don't contact us) and Planetarium Hypothesis (our universe might be a simulation). Also acceptable: wrong technology, we're too early.

7. Intelligent life might develop commonly but destroy itself quickly — through war, environmental collapse, or dangerous technology. The silence = civilizations don't last.

ANSWER KEY — SECTION B

1. narrowband
2. Fermi Paradox
3. transmit
4. staggering
5. reckless
6. Zoo Hypothesis
7. Great Filter

DISCUSSION EXTENSIONS

C1 extension: Who should decide whether humanity broadcasts? A government? The UN? Scientists? Everyone? Discuss the ethics of one person or group making decisions that affect all of humanity.

C2 extension: Compare this to real-world frameworks like Drake Equation. Have students research current SETI projects (Breakthrough Listen, FAST telescope in China) and present findings.

Link to Lesson 1: In the Dark Forest Theory, Ye Wenjie broadcasts Earth's position and invites the Trisolarans. Was she right? Was she a traitor or a visionary?

Real-world connection: In 2017, the interstellar object 'Oumuamua passed through our solar system. Harvard astronomer Avi Loeb argued it could be alien technology. Most scientists disagreed. Discuss: how should we evaluate extraordinary claims?

KEY DISCUSSION LANGUAGE

Weighing risks: "The potential benefit is... but the risk is..."

Historical analogy: "History shows us that..." / "This is similar to when..."

Uncertainty: "We can't be sure, but..." / "Given what we know..."

Challenging: "But what about...?" / "That assumes that..."

Speculating: "It's possible that..." / "One explanation could be..."

Evaluating: "The strongest argument for/against this is..."