Framework for analyzing the Fermi Paradox, Aliensv3, 6/14/26

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Introduction

The Fermi paradox asks: if the galaxy contains vast numbers of habitable planets, why has no evidence of extraterrestrial intelligent civilizations been observed? In other words, if the galaxy is teeming with life, where is everybody?

Based on the immense number of planets (billions in the milky Way) and the opportunity for evolution like ours on earth, Intelligent Civilizations (IC), with the ability to communicate, should be common, but no contact or proof exists via direct communication, planet/galaxy technosignatures or confirmed probes/UFOs. This is the Fermi Paradox. Is there a way to analyze this paradox?

The apparent absence of contact can be explained in two ways: IC are extremely *rare*, or IC exist but have not been *detected*. To analyze the paradox, the framework has four steps. The first two steps address IC rarity based on pre-biological considerations and subsequently biological considerations. Steps three and four explore detection by analyzing temporal overlap and radio communication constraints.

This framework, a conceptual methodology, is modular with basically independent steps. Note that the framework has three underlying assumptions: water is a basic requirement, life is biological and carbon based, and detection is based on radio communication.

First Step. Pre-Biological five phases and calculations

The first step defines pre-biological filters in five sequential phases graphically shown in Figure 1: A. Milky Way Habitable Zone (HZ); B. Pre-planet stellar environment; C. Long-term stable HZ planets; D. Planet Habitability (life can exist); and E. Climate/chemistry (life can persist).

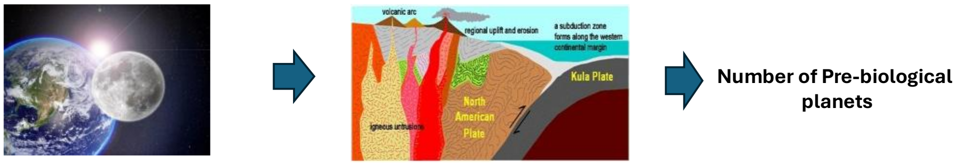
The calculations for the number of habitable planets in the Milky Way based on the pre-biological bottlenecks (filters) is shown in Table 1. The probabilities are estimates and do not represent direct measurements. Each of the bottleneck's survival conditional probabilities is expressed as fraction for all calculations. These fractions can be independently challenged, revised, or replaced based on new research. The conclusions do not depend on any single parameter choice, but on the cumulative effect of sequential constraints. While dependencies between some bottlenecks likely exist - for example between rocky planet occurrence and magnetic field generation, planet mass and atmospheric retention, or land fraction and climate regulation – the impact of such correlations is unknown. Future exoplanet observations will refine individual terms or collapse correlated factors, although the cumulative suppression from sequential constraints is not expected to vary more than an order of magnitude.

Galactic Habitable Zone, GHZ (A1-5)

The starting point for the calculation is the total number of stars in the Milky Way, estimated at 200 billion. The spectral-type fractions follow standard stellar population statistics for the Milky Way disk; M type stars dominate the Milky Way accounting for approximately 75% of all stars, with 10% G type and 12% K type; remaining stellar types are excluded due to short lifetimes and limited numbers.

A fraction of Milky Way stars exist in habitable zones with moderate supernova rates and long-term orbital stability which primarily reflects stellar density within the galactic disk. This equates to the Galactic Habitable Zone (GHZ) fraction, 0.2. Thus, after applying GHZ constraints, the effective number of candidate stars is reduced for all spectral classes and yields approximately 4.0×10^{9} G stars, 4.8×10^{9} K stars, and 3.0×10^{10} M stars. These are metal-rich (C, O, N, Mg, Si, and Fe) second and third generation stars necessary for rocky planet formation.

A. Milky Way Galactic HZ **B. Pre-planet Stellar Environment: radiation, multiple star system** **C. Planet long term stable HZ: rocky, orbit stability, 1 Gyr HZ**



D. Planet Habitability (life can exist): atmosphere, water, land **E. Climate/chemistry (life can persist); plate tectonics/cycling of elements**

Figure 1. Pre-biological five phases

Pre-planet stellar environment for potential planets (B1-4)

This calculation accounts for early stellar conditions before stars reach their Main Sequence (MS). Pre-MS high-energy radiation suppresses habitability for close-in planets, particularly for M stars, where prolonged pre-MS luminosity and XUV output are over an order of magnitude more damaging to close-in HZ planets than for G or K stars, 1 versus 0.1. Thus, M star's numerical dominance, about ten times more stars, is negated by an equal magnitude damaging high pre-MS stellar radiation which may eliminate/reduce water and atmosphere from a potential planet.

The fraction of multiple-star systems that permit stable habitable-zone orbits depends on binary separation, eccentricity, and whether planets occupy S-type (circumstellar) or P-type (circumbinary) configurations. Stability criteria differ among dynamical studies, and observational surveys indicate a substantial population of wide binaries that remain dynamically favorable However, multiple star systems are less stable than single stars, thus, only systems permitting ≥1 Gyr stable HZ orbits are retained, about 45% of net G/K/M stars. After these computations, ~5.3 billion Milky Way stars are possible homes for planets.

As Table 1 shows, except for spectral-type fractions and pre-main-sequence radiation, all other bottleneck values are assumed constant across stellar types. This is arbitrary but acknowledges the difficulty in discerning among stellar types.

Planet physical characteristics (C)

Rocky planets in HZ (C1)

The commonly cited Kepler-based estimates for rocky planets in the habitable zone around Sun-like stars cluster around ~0.1–0.3 per star, depending on definition of "rocky" and HZ width. Adequate planet size assures sufficient gravity for long-term atmospheric retention and is required.

Adopting a representative habitable-zone rocky planet occurrence rate of ~0.2 per Sun-like star is consistent with Kepler-based observational estimates. While occurrence rates vary by spectral type, for M dwarfs a higher occurrence is often estimated (~0.3–0.5), for simplicity a uniform value of 0.2 is adopted for all three of the star types.

HZ stability ≥ 1Gyr (C2)

Long-term orbital stability depends on system architecture and spacing between planets and the adopted habitable-zone definition. More restrictive classical HZ limits motivate lower fractions, whereas expanded boundaries assumptions motivate higher fractions. Assuming continuous residence in the HZ is necessary for at least one billion years, a 10%

probability is assigned. This means a planet remains in a dynamically stable orbit within the habitable zone, avoiding strong perturbations from giant planets or stellar companions.

Magnetic field (C3)

Magnetic field generation and persistence, providing planet protection/shielding, depend on core size, heat flow, rotation, and the coupled thermal evolution of mantle and core. As with Earth, a magnetic field provides necessary atmospheric protection from cosmic rays and excessive radiation, a 30% probability.

Moon and large planet (C4, C5)

Two stabilizers, considered optional (probability = 1) based on their uncertain impact on a planet's long-term HZ position, are a large orbiting moon and giant planet in the solar system. A planet having a large moon like earth's is not very probable (< 0.1), although if present, it supports planet obliquity/rotation stability. However, alternative processes**,** such as favorable multi-planet configurations, low-eccentricity orbits, or rapid planetary rotation might perform the same function.

A giant planet in the solar system, like Jupiter, provides impact regime shielding and comet/asteroid clearing that protects the planet, but the requirement is debatable. Not counting either potential bottleneck is an arbitrary decision.

Planet Habitability, life can exist (D)

Atmospheric retention (D1)

Atmospheric retention depends on gravity, stellar XUV history, escape efficiency, and subsequent replenishment via volcanic outgassing or secondary atmosphere formation. Outcomes vary widely with planet mass, composition, and irradiation histories. The probability a planet can retain an atmosphere, is 20%.

Sustained liquid surface water (D2)

Habitable-zone placement is necessary but not sufficient for long-term surface water. Climate feedback (including clouds and greenhouse balance) can produce divergent outcomes such as water worlds or ice worlds. Thus, there is a 30% probability for sustaining liquid surface water.

Exposed land mass (D3)

The prevalence of water worlds versus mixed land–ocean planets is unknown and not currently observable with available instruments. Land fraction matters for weathering,

Step one	**Fraction and**	**Stellar type and Comments**		
Pre-biological bottlenecks/filters	**stars/planets**	**G**	**K**	**M**
A. Galactic (Milky Way) Habitable Zone	Stars			
1. Potential Milky Way stars	2.0 x 10^{11}			
2. Stars in Galactic HZ (GHZ)	0.2	Spiral arm density, less supernova		
3. Stars after galactic filtering	4.0 x 10^{10}			
4. Spectral-type fraction G/K/M stars		0.1	0.12	0.75
5. Stars total and G/K/M net, 97% of stars	3.9 x 10^{10}	4.0 x 10^{9}	4.8 x 10^{9}	3.0 x 10^{10}
B. Pre-planet stellar environment				
1. Pre-MS radiation eliminate/reduce H_2O/atmos. (M stars)		1	1	0.1
2. Number of G/K/M stars after M reduction	11.8 x 10^{9}	4.0 x 10^{9}	4.8 x 10^{9}	3.0 x 10^{9}
3. Multiple/single star system with stable ≥1 Gyr orbit	0.45	Unstable orbits, more variables		
4.. Total net available G/K/M stars in Milky Way = B	**5.3 x 10^{9}**	Stars available for hosting planets		
C. Long-term stable HZ planets	Planets			
1. Rocky HZ occurrence	0.2	Planet in HZ and adequate size		
2. Continuous HZ residence and orbit stability ≥ 1Gyr	0.1	Suitable spacing, size of planets		
3. Magnetic field (for protection/shield)	0.3	Provides cosmic ray protection		
4. Large Moon for obliquity/rotation stability	1*	Optional, promotes orbit stability		
5. Jupiter - giant-planet (impact regime modifier)	1*	Optional, possible shielding		
Fraction net	6 x 10^{-3}			
D. Planet habitability (life can exist)				
1. Atmosphere retained (pressure and persistence)	0.2	Based on gravity, radiat., volc. act.		
2. Sustained liquid surface water	0.3	Avoid waterworld and ice world		
3. Exposed land	0.3	Required for land animals		
Fraction net	1.8 x 10^{-2}			
E. Climate/chemistry (life can persist)				
1. Long-term climate regulation	0.2	Provide carbon-silicon cycling		
2. Plate tectonics/geochemical cycling elements	0.5	Assures O, N, P		
Fraction net	0.1			
Summary Pre-biological probabilities				
1. Pre-biological planets probability, P = C x D x E	**1.1 x 10^{-5}**			
2. Pre-biological planets, Planets = B x P	**58,000**			
* Optional stabilizers. Not included in baseline.				

Table 1. Pre-biological bottleneck calculations

Climate/chemistry, life can persist (E)

nutrient cycling, and long-term climate stability. Land requirement probability is estimated at 30%.

Long term climate regulation (E1)

Long-term climate regulation depends on carbon–silicate cycling efficiency, tectonic regime, volatile cycling, and surface–interior coupling. The probability of a long-term carbon–silicate cycle, 20%.

Plate tectonics and cycling elements (E2)

The prevalence of Earth-like plate tectonics is unknown; outcomes depend on planet mass, heat flux, lithospheric strength, and water content. Regarding oxygen, if too much is present when the core forms, that leads to phosphorus remaining in the mantle (no longer available to form DNA or RNA). Thus, only in a narrow range of medium-level oxygen conditions — known as a chemical Goldilocks zone — will phosphorus remain in the mantle in sufficient quantities. Element recycling caused by plate tectonics is a 50% probability.

Results of pre-biological bottlenecks

The combined pre-biological probability for habitable pre-biological planets is P = C x D x E, ~1.1×10^{-5}. Thus, assuming all bottlenecks, except one, have the same values, there are a total of ~58,000 ($5.3 \times 10^{9} \times 1.1 \times 10^{-5}$) pre-biological habitable planets that have ever existed in the Milky Way. Prior to considering biological constraints, the number of long-lived habitable planets per Milky Way–like galaxy is significant (but not millions).

This estimate is comparable to other calculated values that range from ~0.6×10^{5} to 2.5×10^{5} Earth-like habitats in the Galactic disk [Lammer et al. 2024].

Second Step. Biological Evolutionary Constraints

The second step calculates, using the Carter equation of "hard" biological emergent steps [Carter, 1983], the biological probability of IC existing over a star's habitable lifetime and then estimates the number of IC in the Milky Way by multiplying the number of habitable planets from step one by the probability that IC evolves. The framework's steps two through four are listed in Table 2.

In the Carter model, the probability, P, of completing all sequential steps, biological evolutionary bottlenecks, within a given time (t) is based on the star type and three parameters: n = number of hard evolutionary hard steps, s = characteristic timescale per step, and t = the effective habitable duration of the planet (having passed all pre-biological filters). Following Carter's hard-steps method, the emergence of IC is treated as the last step in a sequence of rare evolutionary transitions occurring within the available habitable window. The equation is: $P = (t/(ns))^n$ for $t < ns$ and $P = 1$ for $t \geq ns$.

Although Carter did not identify the nature of each hard step, other scientists have recommended n in the range of 4-7 steps [Mills et al., 2025]. Reference Table 3 for a proposed seven step model that includes: Abiogenesis, Eukaryotic Life, Planetary Oxidation, Multicellular Life, Complex Multicellular Life (includes intelligence displayed in whales and dolphins), Advanced Intelligence (humans), and Technological Intelligent Civilizations (referred to as ICs, advanced societies capable of electromagnetic communication, nuclear weapons, internet, AI, etc.).

Step	**Framework steps two-four**	
Two	Biological Filters, hard evolutionary steps (n)	7
	Timescale per step (s in Gyr)	1
	Effective habitability window (t in Gyr)	5
	Carter probability IC formed over star's life	0.0949
	Total MW estimated IC = Planets x IC formed	
	Number of planets	5.5×10^4
	Times Carter probability	~0.1
	IC total	5.5×10^3
Three	Expected present-day civilizations	
	Civilization longevity (L years)	10,000
	Galactic timescale (T years)	10×10^9
	Galactic time available (T_A years)	5×10^9
	Temporal overlap fraction, $F_A = (L/T_A)$	2.0×10^{-6}
	Present-day IC (F_A x IC total)	1.1×10^{-2}
Four	IC detected in 12,000 Lyr radius	
	Percent of galaxy, 0.06 x Pres. Day IC	6.6×10^{-4}

Table 2. Calculations for steps two-four

Stellar dependence enters the Carter model only through the variable t. The t window for G/K/M stars is assumed identical at ~5 Gyr. This is comparable to earth's 4.6 Gyr evolutionary history. Although K stars have much longer main-sequence lifetimes than G stars, planetary geological and atmospheric evolution limit continuous surface habitability to modestly longer intervals but for simplicity, an effective habitability window is also ~5 Gyr. For M-type stars, despite extremely long stellar lifetimes, close-in habitable-zone orbits, tidal effects, and long-term climate stability considerations dictate a similar effective window of ~5 Gyr.

As shown in Table 2, the time per step, *s*, is assumed to be 1 Gyr and the number of steps, *n*, equals seven. A comparison of Carter probabilities shows that reducing the number of hard steps from seven to five or reducing the characteristic step timescale from 1 Gyr to 0.5 Gyr, increases the probability of success within a 5 Gyr window from ~10% to near unity.

	Event	**Time***	**Comment**	**Examples**
0	Earth habitable	0	Relative initial start, 4.5B years ago	Earth
1	Abiogenesis, Prokaryotic life	0.5	One time event, self-replicating, one cell, no nucleus	Bacteria, methanogens, thermophiles
2	Eukaryotic life	1.5	One time event, self-replicating, one cell, nucleus, organelles, DNA	Amoeba, algae, yeast
3	Planetary oxidation	0.75	Global transition enabling high energy metabolism, requirement for large complex organisms	Atmospheric oxygen
4	Multicellular life	1.5	Evolved multiple times (25-30), larger and need more energy, require oxygen, less adaptive than microbes	Animals, plants, fungi, algae
5	Complex multicellular life	0,5	Evolved very few times, organs, nervous systems, basic intelligence	Primarily animals
6	Advanced intelligence	**	Large brains, abstraction, cumulative culture	Humans
7	Technology civilization	**	Nuclear capability, electromagnetic communications	Industrial society, atomic weapons, TV, internet
	Total	4.25		

* Observed elapsed time, in Gyr, between successive transitions on Earth; these values represent one realized history.

** Lapsed times for final steps are not shown because short, realized intervals do not imply low intrinsic difficulty.

Table 3. Hard Evolutionary Steps

After non-biological filters reduce a planet's habitability by four orders of magnitude, the minimal effect of biological filtering, in the range of 0.1 to 1.0, is surprising.

The resulting IC fraction for G/K/M stars is 0.0949. Multiplying this fraction and the pre-biological number of eligible planets, 58,000, yields an estimated 5,500 IC ever arising over the Galaxy's lifetime. Thus, the galaxy is not teeming with IC, but thousands certainly may have existed.

Step Three. Present-Day Civilizations and Temporal Overlap - How long they last.

The third step calculates the number of present-day IC considering temporal overlap. The equation uses lifetime of civilization (*L*) and lifetime of the galaxy (*T*). A discussion of the potential impact of non-biological technology (AI machine-based technologies) is also included.

Direct overlap calculations

To estimate the number of IC coexisting at the present cosmic period, a temporal overlap factor is applied to the total number of IC that have existed over cosmic history.

The overlap fraction, F, is defined as the ratio of civilization longevity, L, to the relevant cosmic timescale T. For $L << T$, this suggests $F = L/T$. The assumption for IC longevity is $L = 10{,}000$ years. The cosmic timescale for a spiral galaxy is $\sim T = 10^{10}$ years. However, T must be modified for galactic time available (T_A years) since only the last ~5 Gyr of galactic history has been capable of producing IC comparable to Earth evolutionary duration. Thus, there exist an evolutionary delay of ~5 Gyr and $T_A = T$ minus evolution delay or 5 Gyr (10 Gyr – 5 Gyr). This results in an overlap fraction of $F_A \sim 2 \times 10^{-6}$. Applying this factor to the ~5,500 IC that have arisen over the history of the Milky Way yields virtually no IC existing at the present period $\sim 1.1 \times 10^{-2}$.

If the typical longevity of civilizations exceeds 10,000 years, the expected number of contemporaneous civilizations increases proportionally and conversely decreases proportionally; one factor that may decrease longevity is the Great Filter (ahead of us) which contemplates a civilization self-destructing via nuclear war or ecological death. Conversely, extended lifetimes might result from an IC transitioning to non-biological forms. The AI impact is discussed next.

Non-biological future of IC

How will AI or advanced technology change IC's lifetime, L, in the temporal overlap equation? There are two opposing views on this issue. The first more obvious view is that *L* would increase dramatically since non-biological systems may exist indefinitely, well beyond IC based on biology. In a second view, lifetimes decrease by destabilizing IC. Thus, there is potential to fundamentally alter the lifetime of IC.

In the first view, AI enables civilizations to transcend biological constraints. Machine-based AI systems are not limited by metabolism, reproduction, or harsh environments and could, in principle, persist for millions or billions of years. In this scenario, intelligent civilizations transition into long-lived, post-biological forms, greatly increasing their longevity, *L*. Martin Rees supports this concept: "Few doubt that machines [AI] will gradually surpass … our distinctively human capabilities. Will this take decades or centuries? Either way the timescales for technological advance are but an instant compared to the three or four billion years of Darwinian selection that led to humanity's emergence … Humans could be a transitional species, marking the end of Darwinian evolution, but jump-starting evolution of machines that themselves over the next few billion years design a succession of ever more capable ones." [Rees, 2024].

In the second view, advanced AI reduces the longevity of IC by raising the probability of self-destruction. For example, AI societies may experience accelerated technological change that outpaces social, political, or ethical adjustment, increasing the probability of collapse. Also, AI may create destructive technologies, for example, chemical/biological weapons, which destroy humanity. An extreme position of this second view, described as the Great Filter ahead of us, assumes AI always destroys its creators.

Although a significant factor, longevity is dictated by assumptions about the future, not empirical evidence, thus a compromise quantitative assumption, AI does not change the previously calculated number of present-day IC in the Milky Way $\geq \sim 1.1 \times 10^{-2}$.

Step Four. Detection - Why do we not see them?

Detection overview

Detection of an IC is either circumstantial via technosignatures or definitive. Technosignatures provide circumstantial evidence, possibly strong evidence, of IC life. They may represent artificial processes or structures. Examples are a) byproducts of energy consumption - chemical pollutants or industrial gases; b) artificial lighting; c) waste heat from excessive energy consumption; and d) orbital megastructures, for example, hypothetical Dyson spheres (large energy collectors used by advanced IC society to harness more energy from their sun). However, distinguishing between natural and artificial technosignatures remains a major challenge. Although some technosignatures may be detectable at distances far beyond radio technology they provide circumstantial evidence and thus are not included in the analysis.

Definitive detection can be physical, for example, discovering interstellar objects (spaceship/probes) or an IC's message, as in the movie Contact. Commonly cited reasons for not receiving messages are: vast interstellar and intergalactic distances – millions and billions of light years for remote galaxies – a major factor for receiving messages; communication technology not based on electromagnetic radiation (photons), but possibly based on more speculative technology, for example, gravitational waves, neutrinos, dark matter or other means; lack of an ICs motivation to pursue contact or reveal existence; and energy requirements for communication/travel – conserving energy might be a priority.

Detection using radio communication.

The analysis in this step focuses specifically on definitive detection of a message using *radio communication technology*. It calculates detection limitations arising exclusively from vast distances in space. A recent study concluded that 12,000 light years was the maximum distance a strong directional radio transmission could be detected based on realistic assumptions about transmitter power and receiver sensitivity [Sheikh, 2025].

Given the flattened geometry of the Milky Way's disk, an area-based comparison is appropriate. A detection radius of 12,000 light-years corresponds to approximately 6% of the Milky Way's disk area (relative to a galactic radius of ~50,000 light-years). Applying this geometric constraint to the estimated ~1.1×10^{-2} IC that survive temporal overlap, yields an expected detectable number of IC on the order of 6.6×10^{-4} i.e., effectively zero.

Based on previous assumptions, the detection analysis demands two conclusions: first, the probability of receiving a radio message from within the Milky Way is realistically negligible; and second, direct radio communication from beyond our galaxy is virtually impossible. However, would optimistic assumptions change this conclusion?

Sensitivity with optimistic assumptions

A high-level sensitivity analysis is now appropriate with the objective of choosing optimistic assumptions. The four steps that potentially could increase the number of IC with different assumptions are: pre-biological bottlenecks; biological evolutionary constraints; temporal adjustments; and detection constraints. How does the result change when using very optimistic assumptions?

Future exoplanet research will clarify pre-biological bottlenecks, possibly adding or correlating factors. If the overall impact were changed by two orders of magnitude, a combination of fewer bottlenecks and higher probabilities, then the Milky Way would contain ~5.8 million habitable-zone (HZ) planets (58,000 x 100).

If the biological evolutionary calculation had fewer hard steps, say 4, or shorter duration hard steps, say 0.5 Gyr, an IC evolving would be assured, resulting in 5.8 million IC. This is because for optimistic scenarios the Carter expression exceeds unity and is therefore capped at $P = 1$.

Considering temporal adjustments, if IC lifetime extended one hundred times longer (10^4 to 10^6 years), the temporal overlap factor F_A (L/T_A) increases from 10^{-6} to 10^{-4}. Thus, there would be 1,160 contemporaneous IC ($5.8 \times 10^6 \times 2 \times 10^{-4}$).

The number of detectable civilizations via radio communications scales approximately with the square of the radius because the Milky Way is a thin disk. Increasing the detection radius from 12,000 lyr to 50,000 lyr increases the searchable area by a factor of about 17 (0.06 x 17 = ~1), so almost all the IC might be detectable, ~1,000.

How are the results impacted if the most optimistic scenario for these four steps – hundred times improvement in pre-biological survival, an accelerated biological evolution, two orders of magnitude longer civilization lifetime, and maximum galactic detection coverage - is used in the calculations? In this high-level sensitivity analysis, reducing the constraint impact by a factor of ~1.7×10^6 (100 x 10 x 100 x 17) results in an expected detectable IC of ~1,000 out of a few billion Milky Way planets within 50,000 Lyr, not favorable odds but not impossible (reference Table 4).

Summary and Sensitivity	**Assumed**		**Very optimistic**	
Start with 2×10^{11} stars in Milky Way	**Fraction**	**Planets**	**Fraction**	**Planets**
Pre-biological Bottlenecks (Step One)	2.9×10^{-7}	58,000	2.9×10^{-5}	5.8×10^{6}
Biological filter probability (Step Two)	0.095	5,500	1	5.8×10^{6}
Present day IC, temporal overlap (Step three)	2×10^{-6}	1.1×10^{-2}	2×10^{-4}	1,160
IC radio detection (Step Four)	0.06	6.6×10^{-4}	~1 (17xs)	~1000

Table 4. Sensitivity analysis

Conclusion

The article started with a question: If the galaxy is teeming with life, where is everybody? The four-step framework addressed the two implied issues: are ICs intrinsically rare, and what factors impede their detection. This framework provides a quantitative resolution of the Fermi paradox by challenging its core assumptions: IC should be common and detectable.

The first two steps estimate the number of IC that arise, concluding that 5,500 IC evolved over the Milky Way's lifetime. This number reflects the large cumulative effect of sequential bottlenecks for non-biological planet habitability, comparable to Earth's environment, and the modest effect of biological hard steps for the evolution of an IC.

Although thousands of intelligent civilizations may have arisen over the Milky Way's lifetime, when temporal overlap is considered, the number of IC in the present time declines to 1.1 x 10^{-2}, virtually zero. After distance radio detection constraints are considered, the expected IC will drop more than an order of magnitude to 6.6 x 10^{-4}. Thus, the absence of contact, via radio communication, is predictable, and thus, the silence of the Milky Way galaxy is an expected outcome rather than a paradox (even in optimistic scenarios).

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