



The Possibility of Detection of Extraterrestrial Life on Other Worlds

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ABSTRACT

Discovery of many extra solar planets with some of them having conditions favourable to harbour life have raised hopes for earth alike biological destinies and evolutionary consequences elsewhere in the universe. This paper is an attempt to hypothesize the earth alike evolution and biological destiny for emergence of Extra-Terrestrial Life (ETL) and Extra-Terrestrial Intelligence (ETI) on an exoplanet. Extraterrestrial life could be unimaginably different in its form, shape, composition, dimension, functionality, evolution and even in biochemistry from the life that evolved on earth and might be inconceivable to us. Therefore, some innovative ways and means of detection of extraterrestrial life are also being discussed, so as to keep the possibilities of detection alive. Furthermore, an attempt has been made to modify the Drake equation for quantifying our nescience about the number of earth approaching intelligent alien civilizations of our milky way and fractions f_h , f_g , f_v , f_t have been included in this equation for this purpose. The fraction f_h denotes the alien civilizations which develop technologies to detect habitable zones in the galaxy, the fraction f_g of such alien civilizations which develop intragalactic travel technologies, the fraction f_v of those alien civilizations which start their voyage towards our solar system and the fraction f_t of earth approaching alien civilizations who wish not to hide them in the earth's environment or in our near and or far space and who's technological or physical presence is conceivable to us through our sensory range and or technology spectrum. The factor T stands for the average travel time for such intelligent aliens to reach earth.

However, as of now there is no scientific evidence of extraterrestrial life. Further, the search for extraterrestrial life is constrained by our limited observations in the infinite cosmic sea with vast distances and limitations of the present day technologies.

Keywords: Exoplanets; Extraterrestrial Life (ETL); Extraterrestrial Intelligence (ETI); Search for Extraterrestrial Intelligence (SETI)

INTRODUCTION

Scientific quest for search of exoplanets and extraterrestrial life

Discovery of more than 4000 extra solar planets or exoplanets orbiting stars other than sun in small sectors of our galaxy alone have raised hopes for the extraterrestrial life [1-12]. Among them are some extra solar rocky planets of the size of few earths with conditions considered suitable to harbour life [13-16].

Life on earth is the product of local astronomical and planetary facts. The small spatio temporal window of the Kepler telescope discovered many extrasolar planets and similar evolutionary consequences elsewhere may not be ruled out [17]. The findings about the existence of molecules in inter solar and interstellar medium which are similar to fundamental to earth's biochemistry point to the availability of building blocks of life elsewhere in the

universe, but we don't understand where and when these molecules become alive [13,18-20]. However, as of now, there is no scientific evidence for or against the existence of life beyond Earth [16].

There are at least 100 billion planets in our Galaxy alone [21] and at least 20% of them are likely to fall in the habitable zone [22], the region of space capable of producing a biosphere. Even if 0.001% of those planets evolved life, that would mean 200000 life-harbours planets in our Galaxy. Using a Biological Complexity Index, the existence of 100 million planets was proposed in the Milky Way where complex life could have evolved [23].

The frequently asked questions pertaining to the scientific formulation of Search for Extraterrestrial Intelligence (SETI) are How abundant, diverse and detectable intelligent alien life is and how does it communicate? During the 20th Century the quest for alien civilizations transformed from justifiable beliefs to technology based endeavour [17]. Drake equation about the 'Intelligent

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Extraterrestrial Life' is that what happens here in our solar system will happen with a large fraction of the stars as they are created, one after another, in the Milky Way Galaxy and other galaxies [16].

$$N=R \cdot f_p \cdot n_c \cdot f_1 \cdot f_i \cdot f_c \cdot L$$

It is neither definitive equation nor inviolable like $E=MC^2$. Its components can be broken down as follows:

N =The number of technically advanced civilizations in the galaxy whose electromagnetic emissions are detectable.

R *=The number of new stars formed in the galaxy each year.

f_p =The fraction of those stars that have planetary systems.

n_c =The average number of planets in each such system with conditions suitable for life.

f_1 =The fraction of such planets on which life actually develops.

f_i =The fraction of life-sustaining planets on which intelligent life evolves.

f_c =The fraction of intelligent life-bearing planets on which beings develop the means and the will to communicate over interstellar distances.

L =The time span over which these civilizations disseminate such signals.

As per the crude estimate of SETI workers based on the guesses and implausible estimates for the factors of Drake equation is that there are about 20,000 detectable civilizations in our galaxy. So far only a few thousand stars have been searched and Search for Extraterrestrial Intelligence (SETI) may succeed only after SETI workers search 10 million stars. Since only 1 in 10 million stars has detectable civilization in 200 or so thousand million stars-studded Milky Way which happens to be earth's home galaxy [16,24]. Drake equation is a quantification of the ignorance arising out of our current state of knowledge about life in the universe.

The number of intelligent biological life bearing habitats in our galaxy are too scattered across the vast distances and time and it would only take one alien life form for our conception of the Universe to change dramatically [25]. Some studies infer that the extinction and evolutionary bottlenecks and their transient or long lasting effects on environment could be deciding factors for the evolution of Extraterrestrial Intelligence (ETI). This way the biological destinies could be different for two planets with absolutely similar environment and seeding material [23]. While some studies suggest that the earth could be unique [26]. Further

there is no other available account for life other than bits, piece of information to draw conclusion about extraterrestrial life [24].

DRIVING SEARCH STRATEGIES FOR EXTRATERRESTRIAL LIFE

The exponentially growing capabilities of our telescopes and systems of today are about 10^{14} times more powerful than the best systems of 50 years ago. This includes 1000 times increase in sensitivity and from monitoring one channel at any moment to hundreds of millions of channels [24]. Traditional methods of Radio astronomy and recent optical methods and controversial idea of active Messaging Extraterrestrial Intelligence (METI) are the methods available for SETI [27-30].

In searching for ETL in the Solar System and on exoplanets, astrobiology is using an approach based on the concept of 'universal heritage', bio signatures including gases in planetary atmospheres and water and carbon as driving search strategies [23,31-37]. In heavenly bodies as big as 10,000 km (nearly earth sized) the processes of plate tectonics, magnetism and atmosphere, gushing out of water from the interior and formation of ocean will happen [38]. Kepler catalogue and ground-based telescope databases of exoplanets in the habitable zone of their parent stars; unexplained signals from known exoplanetary systems are being considered for search of extraterrestrial life [39-41].

Now we have some advanced available tools such as bioneural computing, communication theory, machine learning, neural coding, neural network, deep learning, data mining and big data analysis. These are the tools found in astronomy, astrophysics and also in the biological, geological, cognitive, mathematical and computer sciences, among others. These tools could be conjunctively deployed to detect who, what and where Extraterrestrial Life (ETL) could be and how it might [23]. Clear identification of universal markers and enhancement of our knowledge about the possible exotic biochemistries will in turn improve the standards for search of extraterrestrial life [42-44].

A search strategy centered on earth alike evolution and biological destiny of an exoplanet seems most acceptable for detection of Extra-Terrestrial Intelligence (ETI) on an exoplanet (Figure 1). However, even in this hypothetical situation an altogether higher stage of techno-evolution of an ETI would require us to conjunctively apply many new methods of observation and communication along with the innovative analytics and simulation techniques and some out of the box thinking (Figure 2).

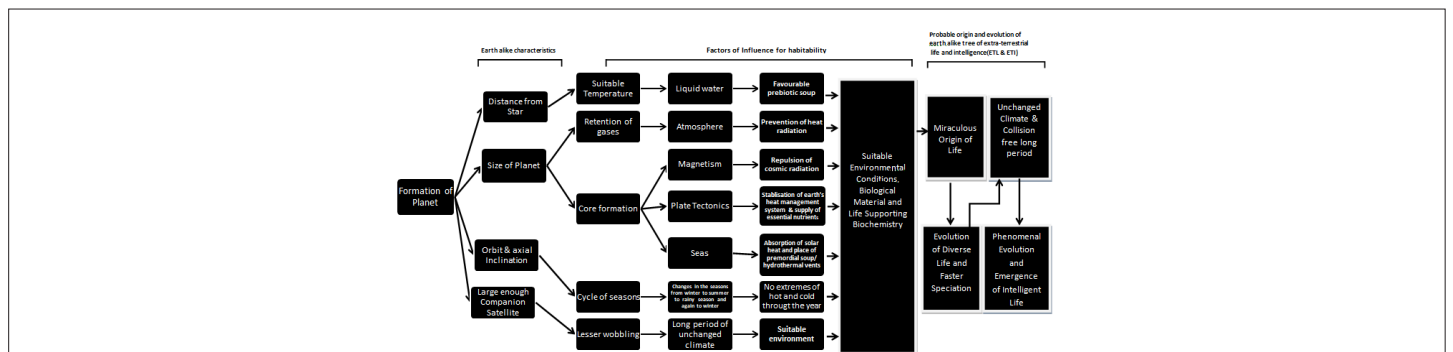


Figure 1: Earth alike evolution and biological destiny for emergence of Extra-Terrestrial Intelligence (ETI) on an exoplanet. Intelligent life might fail to evolve on an exoplanet having life harbouring conditions but with evolutionary trajectory slightly different from earth. Earth alike biological evolution or even advanced biological evolution coupled with an altogether higher stage of techno-evolution of an Extra-Terrestrial Intelligence (ETI) can only culminate into earthward voyage of such an extra-terrestrial intelligence or its machines or may be electronic forms.

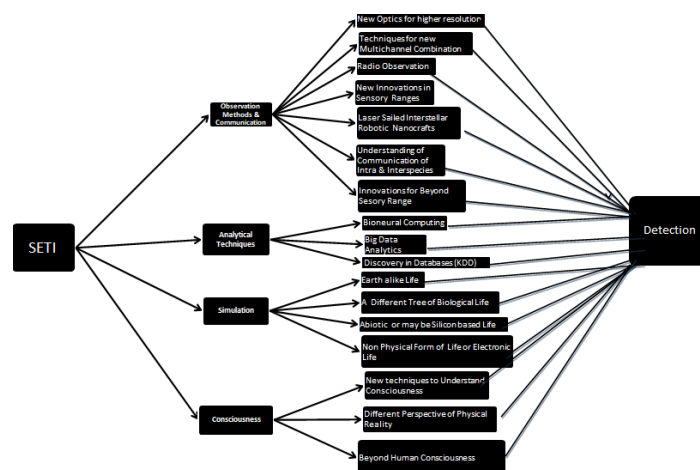


Figure 2: Some innovative ways and means of detection of Extra-Terrestrial Intelligence (ETI) which keep the possibilities of detection of extra-terrestrial intelligence alive but don't guarantee the detection.

Search for the alien life in our solar system

Our neighbouring planet Mars and Saturn's largest moon the Titan and it's another moon Enceladus and one of the moon of Jupiter the Europa are speculated as most promising places in our solar system for finding alien life signatures [16]. An organism would be alien if, and only if, it did not link to our tree of life with a different biochemical basis and genetic history [45]. This secondary genesis or a different tree of life might not be possible if two planets or two satellites of the planets and or a planet and a satellite have exchanged biological material [17].

During the six decades' short history of the space explorations by humans the orbiters, landers and rovers to the nearby planets such as Mars and Venus and passer by missions to the distant outer planets the Jupiter, Saturn, Uranus and Neptune have not indicated any evidence of life on any of these planets or their moons. Even in a rarest among rare possibilities, if at all we find one, it would be rudimentary life.

OUR LIKELY INCONCEIVABILITY ABOUT ETI AT A DIFFERENT STAGE OF EVOLUTION

Life could have evolved much earlier on an exoplanet of a star older than the Sun. The faster evolution of life and intelligence, if at all lead to the rapid pace of technology development could have transitioned the organic form of life into inorganic or may be an electronic form. A technological civilization or otherwise a single integrated powerful electronic brain of unintelligibly intricate machine may communicate in ways far more advanced than our own. The signals of this imaginary super intelligent Extraterrestrial Intelligence (ETI) could not be detectable and decodable to us due to our incomprehensibility to such an advanced ETI. The human perception and communication are severely constrained by sensory range (e.g., wavelengths, amplitude, reach) and by words and limitation will be more acute between interplanetary species that evolved with potentially different conditions and environment [17,46].

If intelligent extra-terrestrials are at an altogether different stage of evolution may be advanced by a few hundred million years or even more may be a couple of billion years, where do we stand in their comparison? Such an advance extraterrestrial life might be inconceivable to us in its complexity, just as human life is to amoeba [16]. Apart from this penultimate hypothetical scenario, there can be a number of intermittent scenarios about the capabilities of

intelligent extraterrestrial who are not a billion years advanced than us. Intelligent aliens technologically a few millennium years advanced than us might not prefer to visit us and the reason could be their ability to use unimaginably much advanced versions of somewhat like 3D printing, geospatial and other technologies to model and simulate on life-size scales, the real world scenarios of geological, biological and technological evolutions of our green planet 'earth'. Some of us may find this kind of galactic scale engineering and technological capabilities of extraterrestrials' very unrealistic and fictional. But the ability to travel interstellar distances are equally unrealistic.

DISCUSSION

SETI: A micro droplet in the vast cosmic sea

The study and understanding of life in the Universe encompasses many, if not all, of the fundamental questions in biology, physics and chemistry, but also in philosophy, psychology, religion and the way in which humans interact with their environment and each other [16]. However, it is not necessary that our comprehension will match all the key factors of reality pertaining to the alien life [17,45,47]. In its current scientific and technological form Search for Extraterrestrial Intelligence (SETI) can be likened to sampling the cosmic ocean with a plankton net, where the size of the antennas and their number are analogous to the mesh size [17]. Moreover our concept of physical reality could be constrained as the perspective of the earth available to plankton whose 'universe' is a spoonful of water. However, we have intimations of deeper links between life, consciousness, and physical reality [46]. The radio observations in the Breakthrough Listen Initiatives aimed at most intensive search for life beyond earth too have so far not fetched any results that indicate intelligent alien life elsewhere [48]. But the project gives us a small chance worth far more than zero [46].

Some innovative ways and means of detection of extraterrestrial life

We can think of expanding our present day knowledge horizon towards SETI through conjunctive use of earth and space based telescopic observations and advanced technology tools. Observation methods, communication analytics and simulation techniques shall be used in conjunction with each other for extra-terrestrial data analysis aimed at detection of ETI. Furthermore, a thought should also be given to combine all these advanced research tools

with the paradoxical idea of consciousness for search of rough guides for detection of ETI (Figure 2). Apart from this, an entirely different perspective of physical reality of ETI beyond the known form, shape, composition, dimension, functionality, evolution, transition, post human technology and hyper intelligence shall also be thought about. Since, extra-terrestrial life could be unimaginably different in its form, shape, composition, dimension, evolution and functionality from the life that evolved on earth. This calls for developing future technologies and conceptualizing an altogether different type of life that is less known beyond human consciousness. As of now the human consciousness is not being used as a tool for SETI. This may be because many of us still consider consciousness as a myth and not as a scientific tool. And we have a limited understanding of human brain and we don't know whether the human consciousness is confined to our brain or is it beyond that so human consciousness as one of the tool for SETI might be the last option which could be exercised only in a scenario when we and our descendents too fail to detect the alien life through technology tools (Figure 2).

Implausible estimates about earth visitor ETI

The big question pertaining to SETI is whether or not we have been visited by Extra-Terrestrial Intelligence (ETI). Claims by non-astronomers that intelligent creatures, or their surrogate machines, have visited the Earth in the past, or are resident today, have not withstood the evidentiary demands inherent in scientific methodology [49-51]. The probability of life to develop intelligence is low in the universe and if there are other forms of intelligent life out there elsewhere, they must be a very long way away otherwise they would have visited earth by now and we would've known if we had been visited [48].

During the course of present study the Drake equation has been modified in the following way for an implausible estimate about our conceivability to the number of intelligent alien civilizations of Milky Way capable of visiting earth:

$$Z = R^* f_p n_e f_1 f_i f_h f_g f_v f_t T$$

Z=Our conceivability to the number of intelligent alien civilizations of our Milky Way who's earth ward voyage can be detectable.

R*=The number of new stars formed in the galaxy each year.

f_p =The fraction of those stars that have planetary systems.

n_e =The average number of planets in each such system that can support life.

f_1 =The fraction of such planets on which life actually develops.

f_i =The fraction of life-sustaining planets on which intelligent life evolves.

f_h =The fraction of intelligent alien civilizations which develop technologies to detect habitable zones in the galaxy

f_g =The fraction of intelligent alien civilizations which develop the technology and will to travel intragalactic distances to the other habitable zones.

f_v =The fraction of super intelligent alien civilizations with intragalactic travel capability which start their voyage towards our solar system or in this direction.

f_t =The fraction of super intelligent aliens approaching earth and who wish not to hide them in the earth's environment or in our

near and or far space and who's technological or physical presence is conceivable to us through our sensory range and or technology spectrum.

T=The average travel time for such intelligent aliens to reach earth.

All the above fractions are proper fractions.

But this hypothetical equation also doesn't answer the question that those imaginary super intelligent aliens who have started their voyage for earth have so far reached here or are still on their way or passed by earth long back. Further, the equation doesn't solve the paradox that consequent upon their arrival would such advanced ETI be conceivable to us or not.

CONCLUSION

During the course of present discussion the Drake equation has been modified for an implausible estimate of the intelligent alien civilizations of our Milky Way whose earth ward voyage can be detectable to us. Fractions f_h , f_g , f_v and f_t have been included in the equation to indicate the capabilities of ETI to detect habitable zones in the galaxy, their intragalactic travel technology, start of earth ward voyage by them and our conceivability to technological or physical presence of such ETI (Extra-Terrestrial Intelligence) respectively. Earth alike physical, chemical and biological environment makes a strong case for origin of life on an exoplanet. However, it doesn't guarantee the phenomenal evolution of Extra-Terrestrial Intelligence (ETI). Since, factors such as lesser diversification and far less speciation of such an alien life as compared to earth and impact of large heavenly bodies during the period of evolution of intelligent life can't be ruled out. Early extinction of nascent life on exoplanets (with life harbouring conditions) will certainly rule out the possibility of evolution of intelligent life out there. Even in some rare cases, if intelligent life evolves elsewhere, it can only visit earth, if it develops the zeal and the technological capabilities for interstellar travel without becoming self-centred or in the worst case self-destructive civilization.

As of now we can't think about the alien life which is not perceivable from our sensory systems and the existing technologies. The possibility of detection of alien life from an altogether different set of gadgets and technologies which are not known to us as yet can't be ruled out. Our resilience to external and those of self-created apocalyptic events in the near and distant future will decide whether or not our remote descendants may visit and or be visited by intelligent extraterrestrials. If it happens in the future, it would certainly be the most spectacular celestial event of human history. Detection of either rudimentary or intelligent aliens will not only end our cosmic alienation but will also open new vistas for our co-existence with the extraterrestrials. Will it happen in our life time or our future descendents will join the enlarged cosmic family as a senior or junior member? The big question remains unanswered.

CONFLICT OF INTEREST

The author declares no conflict of interest.

(The views expressed in this article are those of the author and do not reflect the views of any organization and or institution)

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