A New Perspective in the Search for Extraterrestrial Intelligence

A new study conducted by Dr. Nicolas Prantzos of the Institut d'Astrophysique de Paris (Paris Institute of Astrophysics) takes a fresh look at the Search for Extraterrestrial Intelligence (SETI) and comes up with some interesting conclusions. The study shows that our current attempts at establishing communication with extraterrestrial civilizations via the emission of radio signals may be in vain. It appears that the only likely way to find out whether or not we are alone in our galaxy is to actually go out and explore the space beyond our own solar system.

The results of this study help to illuminate some of the mysteries of the SETI endeavour, and give us further insight into the possibility of finding extraterrestrial civilizations, as well as demonstrating the wide range of possibilities that we may encounter in the future.

The study is based on a joint analysis of the Drake Equation and the so-called Fermi Paradox. The Drake Equation, invented by American Astronomer Francis Drake in 1961, attempts to calculate the probable number of technological civilizations in our galaxy using various astronomical and biological factors. The equation is a product of seven terms, the first three are astronomical in nature and they attempt to calculate the number of "habitable" planets produced per year in our galaxy. The next three terms give the probability of a technological civilization evolving on any given habitable planet, and the last term tells us how long the civilizations last, on average. Although the Drake Equation is quite sound in principle, we still do not have sufficient knowledge of the variables to make an accurate prediction. Ever since the 1960's scientists have attempted to make predictions using the Drake Equation, but results varied greatly between authors. Some found that the number of civilizations is probably quite low (less than a hundred) while others calculate that the probable number is as high as several millions.

Expressed in its simplest form the Fermi Paradox states "If there are many extraterrestrial civilizations in the galaxy, then why haven't we seen them?" The apparent contradiction between the relatively high estimates of the number of such civilizations and the lack of any convincing evidence for their existence causes a sort of paradox. The argument goes as follows: If there are many technological civilizations in the Milky Way galaxy, at least a few of them, presumably, would eventually develop the technology required to travel through space and colonize new planets. Given that the galaxy is very old (approximately 10 billion years) some of these early civilizations would have had more than enough time by now to develop interstellar travel technology, and, assuming they wanted to learn about other life forms in the galaxy, they would have had ample time to explore and colonize the galaxy. Why then, do we appear to be alone?

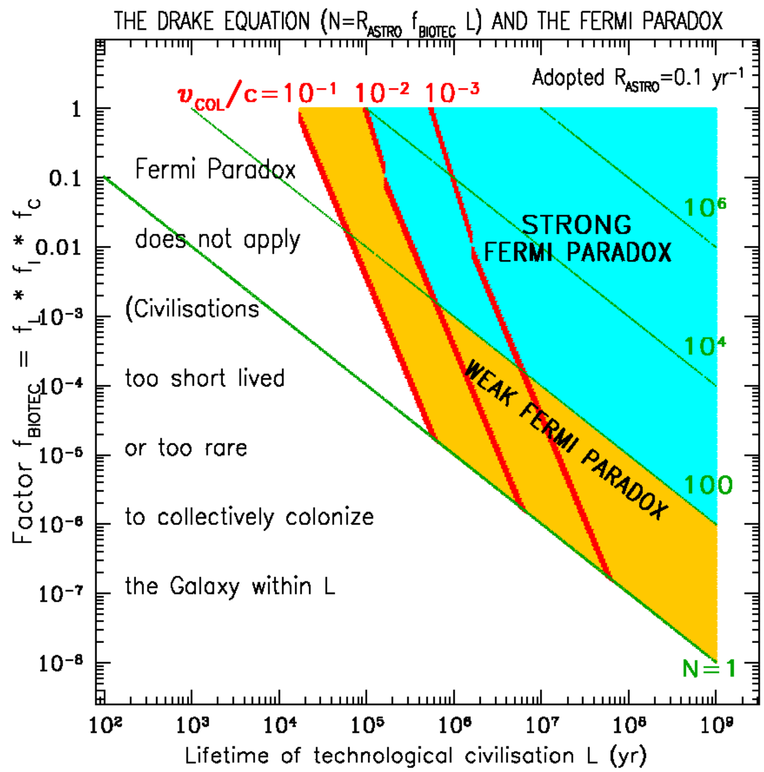
So far the SETI endeavour has been mostly based around sending radio signals into space, in the hopes that an alien civilization will receive our messages. We have also been on alert for incoming messages. However, given the large distances involved and the limited speed of travel (radio-waves travel at the speed of light) it could take tens of thousands of years for any two-way communication to be established between ourselves and an extraterrestrial civilization.

Using recent advances in cosmology Dr. Prantzos estimates that there is one new habitable planet created every ten years in our galaxy. He then creates a mathematical model of the galaxy and finds a relationship between the average distance between civilizations and the total number of civilizations in the galaxy. As one might expect, the more civilizations there are, the closer we are likely to be to any one of them.

As mentioned above, we still lack much of the necessary information required to make accurate predictions with the Drake Equation. Namely, we do not know the biological probabilities of life evolving on a given habitable planet, or the probability of intelligent life eventually evolving from basic single celled organisms. We also do not know the average "lifetime" of a technological civilization. Dr. Prantzos' solution to this problem is to create a graph that shows the entire range of possibilities, depending on the various possible values of these probabilities. The two unknown factors (biological probability and average lifetime) are plotted on an x-y graph. As might be expected, if the biological factor is sufficiently large (meaning that there is a high probability of life developing on a given planet) and/or the average lifetime of the average civilization is sufficiently long, then it is quite likely that we would eventually be able to establish two way communications, although it may take a long time.

Next Dr. Prantzos turns his attention to the problem of the Fermi Paradox and attempts to find a resolution. He devises a simple model of galactic colonization in order to simulate the exploration journey that an advanced technological civilization may wish to undertake. Doing this allows him to determine approximately how long it might take for a civilization (or many) to colonize the entire galaxy, and thus eventually come into direct contact with us. The results indicate that if there are indeed many civilizations (about 1000 or more) then we probably should have seen them by now, which further reinforces the Fermi Paradox. If however, the civilizations are too short lived or too few in number, then that would explain why we have not come into direct contact with them. Another thing to consider is the sociological factors that may prevent an alien civilization from coming into contact with us. If there are few civilizations it is conceivable that they may choose not to explore the galaxy beyond a certain boundary, or may not ever develop space-faring technology, or may choose not to interact with us for some other unforeseen reason. However, as pointed out by Dr. Prantzos "such arguments appear hardly plausible in the case of a large number of independent civilizations."

Dr. Prantzos concludes that "although sending and receiving radio signals is certainly a much easier enterprise than launching starships, the latter should not be too difficult either for a > 10^4 year [10,000 year] old technological civilization." If these civilizations were interested in finding other life forms (intelligent or otherwise) they would incur far better results by actually exploring and colonizing the galaxy, rather than just sitting back on their home planet waiting to receive radio signals. Likewise, we will most likely never know the answer to this most fascinating question until we explore the galaxy ourselves. In the words of Dr. Prantzos: "Detection of some extraterrestrial civilization would undoubtedly be one of the major landmarks in the history of mankind. On the other hand, non-detection of ETI signals, even after millennia of research, would never prove that there were no extraterrestrial civilizations. But it would be reason to prepare ourselves for a life of cosmic solitude."



This figure from Dr. Prantzos' article shows the various positions we may find ourselves in based on the unknown parameters of average lifetime of technological civilizations (x-axis) and occurrence/frequency of said civilizations (y-axis). This helps us determine whether or not the Fermi Paradox applies once we have the relevant information.

I interviewed Dr. Prantzos to get his personal opinions on some of the more interesting questions outlined in his research. The questions and his responses are shown below:

Question: What motivated your research in this topic? Was it purely interest in the subject or was there more to it?

Answer: As far as I can remember, I was always interested in ETI and I knew the Drake Equation since my youth, through one of the books of Isaac Asimov in the 70ies; several years later I learned about the Fermi Paradox, but I realised its importance much later. Although I discussed many times those topics during my popular lectures and with friends, I never did any research myself, except in the last year, after a workshop held in Paris for the 50th anniversary of the Drake Equation.

Question: In your paper you talk about the average lifetime of a technological civilization. What do you think are the primary factors that would lead to the end of a technological civilization? For example: self-destruction, resource depletion, etc…

Answer: This is a question for a sociologist rather than an astrophysicist, but I am not sure that even the former would have much interesting to say on it. Although we have examples of the collapse of civilizations after ruling for centuries or millennia, we have no example of the collapse of a technological civilization, since ours is the first one on Earth. One can imagine dozens of reasons, like the ones you mention, yet none of them appears unavoidable. Just an example: thirty years ago, in the Cold War, the spectrum of a nuclear holocaust appeared to be the number one threat for the survival of our society; now, it has mostly gone. On the other hand, solutions to the Fermi Paradox do not require the technological civilization to come to an end: it is sufficient to think that for some reason "they" do not develop space travel (while using their advanced technology for other purposes).

Question: Although we still lack much of the required knowledge to make a reasonable estimate of the number of technological civilizations in our galaxy, what is your intuitive guess about how many there are?

Answer: Let me answer that question in three different levels:

- I would personally LOVE to know that there are many of them out there: we could learn so much from them! (I don't believe they represent any threat to us)
- Because of the Fermi Paradox and evolutionary arguments I believe that there are extremely few of them and I would not be surprised if it turns out that we are alone in the Galaxy.
- I cannot prove that (but nobody can prove that we are not alone either).

Question: If there are other civilizations, do you think they are quite similar to us in terms of behaviour, societies, etc… Or do you think they could be entirely different from anything we can imagine?

Answer: The second alternative appears most plausible to me. But again, the words "plausible" or "implausible" have little meaning in that context.

References:

- Prantzos, N. (2013). A joint analysis of the Drake equation and the Fermi paradox. 1-17. Retrieved from http://arxiv.org/abs/1301.6411