SETI: The Drake Equation

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The article comments on the basic formula used for the planning of any SETI research program: The Drake Equation. In this report, it is possible to estimate the number of extraterrestrial civilizations in our galaxy with potentially communication skills. Although the content almost exclusively probabilistic, the importance of the Drake equation is primarily methodological in that it highlights the important factors which determine the possibility of the development of intelligent life in the universe.

The idea of using radio telescopes in an attempt to intercept radio messages intentional or typical "electromagnetic leaks" coming FROM technological extraterrestrial civilizations evolved from the end of 1950. The ability to channel information with great power, together with the high sensitivity of modern radio equipment, as well as the existence of an "atmospheric window" in this region of the electromagnetic spectrum, bode well that this technology is the most appropriate for such research.

One of the pioneers in the research by radio (SETI) for extraterrestrial intelligence was the astronomer Frank Drake: he designed a famous formula, known as the Drake Equation, which should help to estimate the number of technological civilizations that may exist in our galaxy, by calculating the average distance between a civilization and the other. The equation was presented for the first time at a conference in Green Bank, in November 1961, the meeting, which was attended by a select group of scientists from different fields of research, was intended to trigger fruitful discussions on the real prospects a search for extraterrestrial intelligence with radio means. The formula that was designed to highlight Drake presented with a simple mathematical relationship, the specific factors that play an important role in the birth and development of intelligent civilizations in the universe. Although it is not feasible to date a unique solution to this equation, it is generally considered by the scientific community, a sure point of reference for meaningful assessments of the probability of existence of technological civilizations in the galaxy. As you will see, each term of the equation represents the possibility of a key step in the evolution of a civilization and the numbers that it brings are purely theoretical: we must not forget that any assessment that you can do in a similar (and delicate) context, has a purely probabilistic, given that most of the values that can be assigned to the various experimental parameters are not relevant, but are the result of more or less based hypothesis (and well-aimed). Even with these limitations, the equation presents undoubted scientific interest, given that illustrates very well the potential of this type of investigation. Quite rightly, it has become the benchmark of all SETI searches in the world.

The hypothesis of Drake motivated by the fact that the number of advanced technical civilizations that may exist in our galaxy, in the possession of the interest and ability to communicate over interstellar distances, it can be reasonably estimated using the following equation:

$$N = R \cdot f_p \cdot n_a \cdot f_v \cdot f_i \cdot f_c \cdot D$$

where R is the average rate of star formation in the galaxy (compared to his age), f_p is the fraction of these that have planetary systems, n_a is the average number of planets (in each planetary system) with environments conducive to development of life, f_v is the fraction of those planets where life actually develops, f_i is the fraction of inhabited planets on which (during the life cycle of the local sun) evolve intelligent life forms with manipulative skills, f_c is the fraction of planets inhabited by intelligent beings capable of a technological civilization progressed, D is the average life span of this civilization. The basic assumption is to express the number N of technological civilizations as the number of suitable stars to sustain life, "weighed" (reduced) by a number of important factors of selectivity (all terms are expressed as fractions with values f between 0 and 1), and reduced again by D factor. It is clearly implied a condition of stationary equilibrium between civilizations that emerge and those that disappear: for each new civilization was born in the galaxy, there is one that dies.

The result of the equation then provides an estimate of the number of intelligent extraterrestrial civilizations (within our galaxy) with which it is assumed, at this time, to be able to communicate. The most delicate aspect of the calculation consists precisely the evident difficulties of reasonably approximated assign values to the parameters, as you do not have any experimental evidence that allows to carry out a sufficiently precise evaluation on their value. The significance of the relationship of Drake should not be overestimated: it only intends to provide guidance about an order of magnitude the number of civilizations existing in our galaxy. Each hypothesis can advance personal and practice how to calculate the value of N by inserting more or less reliable data on the basis of the results derived by recent discoveries of astronomy and bio-astronomy. As we shall see, it can be basically optimistic or pessimistic: the remarkable fact is that, in all cases, the estimation leads to a probability on the existence of intelligent life within our galaxy very close to one.

In recent years, as a result of important astronomical discoveries, it was gradually becoming more accurate values can be assigned to some variables. However, at least three of the parameters of the Drake equation remain completely under speculative. Let's see how it is possible groped an assessment of the Drake equation based on the results of the recent discoveries. The rate of formation of stars in our galaxy is approximately a year and should therefore R = 1. An optimistic assessment, made by C. Sagan and J.Š. Shklovsky, is acceptable to an average rate of star formation in the galaxy of the order of 10 stars for year (R = 10). These extremes can Provide a good idea on the interval acceptable to the values of the parameter R: today may be realistic to assign a value of R 3 or 5.

Based on theoretical considerations and recent observational evidence is also conceivable that often are associated with the planets to the stars belonging to the main sequence: it can be assumed, therefore, that $f_p \approx 1$. To comfort this figure it is worth mentioning that the number of exoplanets discovered is steadily increasing and is closely linked to the availability of new and more sophisticated instrumental technologies, in the near future (with the creation of instruments placed in orbit outside the Earth's atmosphere) are able to directly reveal the existence of Earth-like planets. The scientific community is still quite common agreed that the existence of Earth-like planets orbiting solar-type stars. With similar arguments it is reasonable to assume that the main sequence stars of spectral type roughly similar to the Sun, have a similar distribution of planets with orbits sufficiently stable to allow the existence of liquid water is essential for the origin and development of life. It can be assumed, also in this case, n ≈ 1. If manifest physical-chemical suitable conditions, given a sufficient period of time and an environment which is not completely static, the evolution of biological organisms complexes should be inevitable: the possible and next discovery of forms of life, relatively simple, on Mars or other planets within our solar system would tend to confirm this hypothesis. In our solar system life originated at least once, but maybe two or more: one can then assume $f_v \approx 1$.

The question on the evolution of intelligence is very complex and delicate, since we do not have the opportunity to observe other cases, in addition to our: an estimate of the probability of this happening from biological forms "simple" is just as difficult. Most scientists, however, believe that the galaxy and the Earth is not the only site of beings endowed with intelligence and ability to manipulate, and that once "triggered" the mechanisms of development of this life must necessarily evolve towards smart forms can produce advanced technologies. However, taking into account the fact that so far, in its history, it has developed a single species possess these characteristics (and only very recently), it is assumed, for the moment, $f_i=1/10$. With similar considerations, we can also admit $f_c \approx 1/10$ with regard to the development of technologically advanced civilizations.

The final value of N depends significantly on our waiting for the D average life (in years) of a technologically advanced civilization. This factor is probably the most difficult to estimate. It seems reasonable to assume that at least some advanced technical civilizations in our galaxy every hundred, do not destroy themselves, or lose interest in the interstellar communications, nor suffer by insurmountable biological or geological disasters. How reasonable average for all technical civilization, short-term and long life, you can adopt the provisional value of D $\approx 10^7$ years.

Estimated, although with difficulty, all the parameters, the Drake equation leads to the value, which is considered quite optimistic, N $\approx 10^6$, then a million technologically advanced intelligent civilizations in the galaxy. According to the calculations made by C. Sagan and J.Š. Shklovsky the 0.001% of the stars of the sky should therefore have a prosperous planet on which an advanced civilization and the distance that would separate us from the community closest to us may be of the order of several hundred light-years. However, since the estimates of the factors that appear in the equation of Drake are arbitrary and vary widely, the end result can theoretically range from zero to a few billion advanced civilizations, although the most common approach among scientists, that seems to put agree optimists and skeptics, is a value of N between 10^4 and 10^9, with a range of distance values between us and the nearest technological civilization between 10 and several thousand light-years.

Summing up the above conclusions, we can say that the number of technologically advanced civilizations existing in our galaxy, substantially ahead of our own, could be between 50000 and 1000000. The average distance between the various communities would be between a few hundred light-years away and about 1000 light-years, with an average age for civilization equal to 10,000 years or more. Insist on remembering how each estimate made by working with the Drake Equation (the reader is invited to make his!) Has value only insofar as they are supposed to acceptable values for the parameters, especially for the variable D, and as such values remain necessarily arbitrary since it is difficult to correlate with experimental evidence.

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