The Drake Equation

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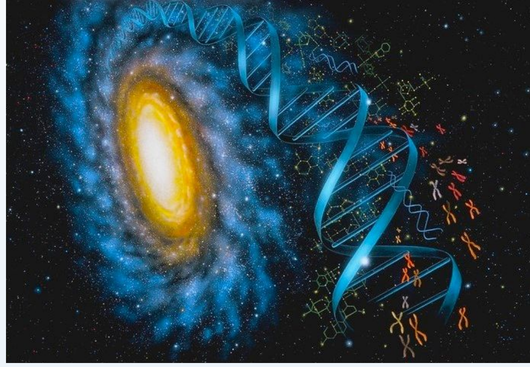

Introduction

The field of astrobiology has many unknowns, and it is easy to lose sight of what is important. That is why many scientists use the Drake Equation as a means for framing scientific discussion on the possible existence of alien civilizations.

The Drake Equation

The Drake Equation is composed of several terms which represent the necessary conditions for intelligent life to arise, as well as the likelihood of these civilizations existing simultaneously with us. While this is not a concrete calculation, it does provide structure for looking at the requirements for life in the universe. It also allows us to clearly visualize what preconceived notions we have, as well as how much we don't know.

Analyzing the Equation

$$N = N_* \, f_s \, N_p \, f_e \, f_l \, f_i \, L/L_{MW}$$

N_* **= 250 billion.** The number of stars in the Milky Way depends on how much mass the Milky Way has, and what percentage of that mass is in stars.

f_s **= 0.24.** The fraction of stars in the galaxy which are sun-like have similar masses, lifetimes, and luminosities as the sun.

N_p **= 4.16.** The number of planets per sun-like star is found by dividing the total number of planets in the galaxy, as found by the Kepler Mission, by the number of sun-like stars.

f_e **= 0.015.** The fraction of Earth-like planets is calculated from the rarity of several factors, including being within a star's habitable zone, having surface liquid water and biogeochemical cycles, and maintaining a stable atmosphere.

f_l **= 0.0075.** The fraction of these planets which evolve carbon-based life depends upon the probability of amino acids and nucleotide bases developing abiogenically from foundational compounds and an energy source.

f_i **= 0.01.** The fraction of life which evolves an intelligent civilization capable of using radio communication is calculated from evidence from the Cambrian Explosion evolutionary event on Earth.

L **= 10 million years.** The average lifetime of an intelligent civilization is the least-known factor. This estimation is based on the lifetime of the parent star and the likelihood that they do not destroy themselves with their technology.

L_{MW} **= 13 billion years.** The age of the Milky Way is estimated from the ages of the oldest stars in the galaxy.

Conclusion

N = 1440 active transmitting civilizations in the Milky Way.
Errors due to N_*, f_e, and f_l lead to possible N values of 38 to 6144. This value means that the average distance between civilizations will be ~8000 light years. The single most important factor was the lifetime of the civilization. With a high L, civilizations are long-lived, therefore likely much more advanced.

Further Explorations

From this information, we could create a density map of the Milky Way showing where civilizations are likely to exist.
In addition, we could use the star formation and death rates to calculate how the value for N will change over time.