

Extraterrestrial Life Group Discussion

Group Assignment

Meet with the other members of your group. Assign group roles. Print names below.

Your name must appear below in order to receive credit.

Recorder - writes down group's ideas

Timekeeper - keeps the group on task within time allowed

Mediator - helps group arrive at a consensus, oversees voting on issues

Clarifier - reads while Recorder writes, makes sure everyone understands

Encourager - makes sure everyone contributes, encourages group members to talk

Speaker - proposes any group questions to TA/Instructor

(In groups of 5, the Encourager is also the Speaker)

Reporter - summarizes group's findings (at the end of the discussion time anyone in the group may be asked to serve as the Reporter)

In this group discussion you will apply what you have learned in your astronomy class and other courses to consider the possibility that life exists elsewhere in the galaxy. You will use the Drake equation to estimate the number of technological civilizations in the Milky Way. In 1961, Frank Drake proposed this equation as a way to estimate how many communicating civilizations may exist in our galaxy and to justify his request to use radio telescopes in an attempt to pick up extraterrestrial radio signals. He received radio telescope time and began the first search for radio signals from an extraterrestrial civilization, the first SETI program. At the end of this activity you should be familiar with the terms in the Drake equation, be able to choose and support a value for each term, and discuss what pessimistic and optimistic values for L and N imply.

The Drake Equation

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

N = number of civilizations in our galaxy capable of communicating over interstellar distances with radio telescopes

These terms multiplied together give an estimate for N . From left to right, the terms become more speculative. You may adopt the value given on the next page for the first term. There is little debate over its value. The other terms will require choosing a number, and supporting reasons for deciding on that value. The "f" terms are "fractions of" terms. This means that their range of values must be between 0 and 1. A value of 1 means every time, certainty. A value near 0 would be very improbable. Actually by setting any of the f terms to 0 you would deny that we are here, so a very improbable value would be 1/100,000,000 (10^{-8}) for example.

Now for the terms:

R_* = rate of star formation in our galaxy for stars with characteristics like our Sun

Let $R_* = 1$ star per year.

This value is based on observation of star forming regions in our spiral galaxy and other spiral galaxies. Stars similar to the Sun (main sequence, 1.5 to 0.7 solar masses) hold the best prospects in finding suitable terrestrial type planets close enough to the star so that water can exist. Also these stars have stable periods lasting billions of years.

Use the value given above in your calculations.

Why would a 10 solar mass star be a poor choice to expect to find a planet on which intelligent life has evolved?

f_p = fraction of stars in our galaxy with planets

For this term be sure to consider the latest information regarding extrasolar planets. Also consider binary stars: if two stars form together how might that affect planetary formation?

Group value for f_p =

Reasons for choice:

n_e = average number of planets suitable for life per planetary system

For this term you need to take into account the temperatures of various stars, whether or not planets would exist where it is possible for water to be present, if the right materials are present, and if conditions might be similar to those on ancient Earth. The zone around each star where liquid water could exist is called the ecosphere. n_e is the average number of planets found in the ecosphere. In our Solar System, clearly there is at least one planet suitable for life, Earth. What about Mars? We are considering "life as we know it" here, since scientifically that is all that we have studied. As our exploration of the Solar System continues we may have to broaden our estimates. You are not limited to whole numbers for this term. A value of 1/10 means that out of 10 stars with planets only one planet would be found to lie in the ecosphere of its star. **Which planets in our Solar System does your group consider to be suitable for life?**

Are there any other planets or satellites that your group considers as an outside possibility for having suitable conditions for life? Explain your choice.

Group Value for n_e =

Reasons for choice:

f_l = fraction of suitable planets on which life develops

Given a suitable setting—right temperature, chemicals, water, conditions very similar to those on ancient Earth—how likely is it that life develops via chemical evolution? A value of 1 means every time. A value of 1/1000 would mean the origin of life is a less likely occurrence. A value of 1/1,000,000,000 (10^{-9}) means a very rare occurrence. Remember, even microbes count as life here.

Group value for f_l =

Reasons for choice:

f_i = fraction of planets with life on which an intelligent species has evolved

On planets with life and biological evolution operating in a similar fashion as on ancient Earth, what are the odds that an intelligent species will develop? This value is highly dependent on what your group considers to be an "intelligent species."

Group definition of "intelligent species"

How many intelligent species are there currently on Earth? Explain.

Group value for f_i =

Reasons for value

f_c = fraction of planets with intelligent species that have developed radio telescopes capable of sending and receiving interstellar messages

Sometimes f_c is referred to as the "technical civilizations" term. Technology has proceeded to the state where instruments are used to communicate using radio waves on the planet. On Earth, scientists realized that objects in space naturally emit radio waves. Radio telescopes were built to study these objects. These antennae can be used to transmit as well as receive radio signals.

Why would a technical civilization be interested in studying radio waves in our Milky Way galaxy? (What can radio waves tell us about our galaxy?)

The human species became a "technical civilization" in the 1950s. What were some of the most important developments our ancestors have made during the last million years on the way to becoming a technical civilization? List at least 3 that your group considers crucial.

If a planet were water covered, but had intelligent marine lifeforms, consider the likelihood that a technical civilization could develop given such a setting? Discuss.

Group value for $f_c =$

Reasons for choice:

$L =$ average lifetime of a communicating civilization

Go around your group and have each member explain what he/she thinks the future of our species will be. Record several ideas below:

This term is the most uncertain, because we have no examples of technical civilizations that have ended. We certainly are aware of some of the problems facing our future survival. The development of radio telescopes came from 20th century technology. Other technological developments of the modern era have tremendous destructive powers.

Talk among yourselves and list the three greatest problems facing humans today.

List three problems that you think technology will be capable of solving during the next century.

Does your group think that our technological development is typical? That is, do emerging technical civilizations nearly always develop radio telescope technology at about the same time they develop the ability for self destruction?

Group value for L=

Reasons for choice:

Now you are ready to calculate your value for N using the Drake Equation.

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L \quad (\text{Show your work.})$$

N =

Would you consider your group value for N, optimistic or pessimistic?

Even with optimistic N values the nearest communicating civilization may still be 100 or more light years away. Why do SETI programs argue that radio communications are more reasonable than interstellar travel?

Some argue that SETI programs make no sense since we have good evidence that the Earth has already had direct contact with extraterrestrials. How does your group feel about the evidence supporting these claims? Discuss.