

Search for Extraterrestrial Intelligence

ASTR 101

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1 Objective

This report will demonstrate how to properly estimate the number of intelligent civilizations there may be inside of the Milky Way Galaxy and how one can calculate how far away the nearest one to Earth may live.

2 Introduction

3 Equipment

The equipment used for this lab is as follows: an image of the centre of the Milky Way Galaxy, a measurement magnifying glass, a Sharp EL-510R calculator, a computer running Windows XP, and a modelling program for radial velocity and star luminosity calculations and data graphs.

4 Procedure

5 Observations

All observations for this report were made on the day of 2012-Nov-19. As all calculations and measurements made inside of this report are based off of given data, weather conditions and time of day have not been reported as they hold no effect. The measurement of how many stars are inside of our Milky Way Galaxy can be found in the Section 6. All other measurements are made using very

rough approximations and their explanations can be found inside of Section 4 along with how they were calculated. Rough calculations and measurements can be found at the back of this lab report as well.

6 Tables and Measurements

Drake Parameter	Measurement	Result
N_*	8	1.2 Billion
f_p	2600	.65
n_e	5	1.25
f_L	-	0.98
f_i	-	0.3
F_s	500,000	6.25×10^{-5}

Table 1: Measurements of parameters inside the Drake Equation.

7 Calculations

To calculate the real number of stars in our Milky Way Galaxy, the measurement of N_* in Table 1 can be multiplied by 150,000,000 to make up the ratio of the measured size of 1 square millimetre. Equation 1 below shows this.

$$N_* = S * 150,000,000 \quad (1)$$

To calculate the fraction of stars which have planets, Equation 2 below is used. By dividing the measurement of f_p in Table 1 by the total number of stars in our sample size, we get the percentage of stars which are estimated to have planets around them.

$$f_p = \frac{P_{estimated}}{S_{total}} \quad (2)$$

To calculate the number of habitable planets in each solar system we simply take the measurement of n_e in Table 1 which is the total number of habitable planets in a sample size and divide by the number of total planets in that sample. This can be seen in Equation 3.

$$f_e = \frac{P_{habitable}}{P_{total}} \quad (3)$$

To calculate the chance that planets have life on them and get the measurement of f_L in Table 1, we take the number of years Earth is known to have life and divide it by the number of years Earth is known to have liquid water on its surface. This can be seen in Equation 4.

$$f_L = \frac{3.9Billion}{4.0Billion} \quad (4)$$

To calculate the lifetime of a civilization, we take the measurement of F_S in Table 1 which is the estimated lifetime of a civilization and divide it by the lifetime of a normal star such as our Sun. This can be found in Equation 5.

$$f_L = \frac{500,000}{8.0 \text{Billion}} \quad (5)$$

To calculate the number of intelligent civilizations inside of our Milky Way Galaxy, we simply take all of the parameters to the Drake equation and multiply them together. This can be seen in Equation 6.

$$\text{IntelligentCivilizations} = N_* * f_p * n_e * f_L * f_i * F_s \quad (6)$$

To calculate the nearest civilization in our galaxy to ours, we find the average area a civilization occupies in the Galaxy and then take the square root of it. This can be seen below in Equation 7.

$$\text{NearestCivilization} = \sqrt{\frac{\pi * 45,000^2}{\text{IntelligentCivilizations}}} \quad (7)$$

8 Questions

The following questions and answers are asked inside of lab 8, Search for Extraterrestrial Intelligence, inside of the lab manual for ASTR101. The questions have been repeated for the reader.

- Q. Would you be able to detect a Jupiter mass planet in a one year orbit?
- A. You would be able to detect a Jupiter mass planet as it has enough mass to pull the star around giving a reading in radial velocity and it is also large enough to give off a dip in the star's luminosity reading. Being able to see these types of planets is a direct cause of the selection effect with our current detection methods.
- Q. Would it be possible to detect planets like the Earth?
- A. An Earth sized planet would not be able to be detected because it is too small to show a dip in the star's luminosity and it is not massive enough to show movement in the star causing radial velocity. These are the reasons the main methods of searching for planets right now do not often show Earth sized planets that are around 1AU away from the star.
- Q. Compare the average distance between civilizations to the lifetime of a civilization.
- A. In this report's estimated case, the distance to the nearest civilization is 595.89 light years while each civilization is estimated to survive for around 500,000 years. This means that the civilizations would be detectable sometime during the lifetime of the civilizations. They would be able to send about 830 messages in total between civilizations in this time span.

- Q. Would our earliest radio signals have made it to the nearest civilizations yet?
- A. Seeing as our earliest radio signals have only been travelling for about 50-60 years, these distant civilizations would not have picked up on them, nor would they see them for another 520 years.
- Q. Based upon your above calculated distance to the nearest alien civilizations, do you expect it to detect any civilizations? Would conversations between civilizations be possible?
- A. I would expect, that sometime during our civilizations lifetime, we would be able to detect some of the more near civilizations in our Galaxy. Communications would be possible, however the full time for one conversation would be well over 1000 years, thus no single human would be able to carry out such a conversation.
- Q. What can you decipher about the creatures that made this plaque? Explain what you base it on.
- A. We can determine that the satellite left from the third planet of its origin solar system and the direction it took to leave that solar system. We know there are two different sexes among the same origin species. We know the origin species height in comparison to the satellite. We can see how the origin species has mapped their star given certain distances away from pulsars and which pulsars are indicated by the distance and spin rate given in the left hand side of the plaque. Finally, we know the hydrogen molecule for a standard measuring device.

9 Conclusions / Discussions

This report has shown how to calculate an estimated number for how many intelligent civilizations there may be inside of our own Milky Way Galaxy as well as how close those civilizations may be to Earth. This report has also answered, through these calculations, the likelihood of contact with these civilizations.

10 Evaluation

I found this report and lab very tedious. I believe that the Drake equation is one of the most ludicrous equations ever created inside of the sciences. Why have we continued to indulge an equation whose margin of error approaches 100%? This makes the equation itself meaningless. Although, the equation does have us thinking in the correct direction and bring to the surface many of the variables that would have to be understood. I am a user of the SETI@home project though and found this report an interesting little side note to the data that is actually being collected and processed in the real world.

References

- [1] Kleine, T.; Palme, H.; Mezger, K.; Halliday, A.N. (2005). "HfW Chronometry of Lunar Metals and the Age and Early Differentiation of the Moon". *Science* 310 (5754): 16711674. Bates, Robin (series producer), Chesmar, Terri and Baniewicz, Rich (associate producers) (1992). *The Dinosaurs!* Episode 4: "Death of the Dinosaur" (TV-series). PBS Video, WHYY-TV.