

John Murrell

Life in the Universe Where are they ?

The Drake Equation

&

The Fermi Paradox

Introduction

- * As an introduction to tonight's event I am going to describe the Drake Equation that estimates how many Alien Civilisations there are in our Galaxy.
- * This will be followed by a introduction to The Fermi Paradox – I am not going to say much about this now as it is better you understand the Drake Equation first
- * To keep within the time limit this will be a very brief introduction



Who is Drake ?

- Frank Drake is a radio astronomer he was one of the first to realise that the new science of radio astronomy could be used to search for the signals from extraterrestrial beings
- As a result he led some of the first searches for extraterrestrial beings by radio in the 1960's.
- He is now Chairman of the SETI institute

The Origins of The Drake Equation

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** Following publication of the (negative) results of Drake's first measurements sufficient interest was shown by other people for Drake to organise a meeting at the NRAO at Greenbank, West Virginia.
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** Since the few measurements had not produced any positive results there was a shortage of material to discuss so Drake decided to devote the three day meeting to calculating how many civilisations there are in our Galaxy that we should be able to receive radio signals from.

Origins

- *** To give some structure to the the meeting Frank Drake wrote his now famous equation on the Blackboard as part of his introduction
- *** This equation estimates the number of civilisations in our galaxy that are communication by radio at the present time (N)
- *** The equation :

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

The equation

- ** Each of the terms describes a factor that effects how many civilisations should exist and how many of them are in the phase of technological development that allows them to transmit radio signals.
- ** The earlier terms are more to do with Astronomy and are possibly more accurately known – the latter terms are more to do with biology & sociology and are more uncertain.
- ** Now lets look at the individual terms.
- ** While doing this we need to be aware of any uncertainty in the estimates caused by our ‘special’ position in the galaxy.

The Term R^*

R^* = Rate of star formation of stars similar to the Sun in our Galaxy

It is estimated that there are around 10 billion stars in The Milky Way similar to the Sun. As the age of the Galaxy is around 10 Billion years the rate of star formation is about 1.

Quoted rate is in the range 1 to 10 per year

The Term f_p

f_p = Fraction of those type of stars with planets

This has been estimated from searches for extra solar planets and is now estimated at around 0.5

Estimates range from 0.5 to 0.2

The Term n_p

n_e = The number of habitable planets around these stars

In the solar system we can argue that either the number should be one (The Earth) or upto 5 if you include Venus, Mars, Europa & Callisto

Estimate 1 to 5

Note all the evidence is based on one example – the Solar System.

The Term f_l

f_l = fraction of the suitable planets that have life on them

The best estimates that life will develop on a suitable planet are that it is certain so the probability is set to one

Estimate probability 1 (certain)

Note if Mars, Europa & Callisto are found to have life on them or that it once existed this will be a lot more convincing !

The Term f_i

f_i = fraction of these that have intelligent life

The best estimates that life will develop into intelligent life was set at one – largely based on the fact that humans are intelligent and supported by intelligence in Dolphins and other animals.

Estimate probability 1 (certain)

The Term f_c

f_c = fraction that develop technological civilisation

Defined as a the ability to communicate by radio. Very little evidence in that humans do but no other evidence

Estimate probability = 0.1

Range – unknown ?

The Term L

L = average lifetime of technological civilisations

This is the length of time that a civilisation exists (in years) from discovering how to communicate by radio until it either destroys itself, is destroyed by natural calamity or finds a better way of communicating.

Estimate Range 1000 to 100 million years

The result

- ✱✱ Working out the numbers gives an estimate for N (The number of civilisations currently communicating by radio)
- ✱✱ Upper limit is 250 Million
- ✱✱ But using the lower estimates this could fall as low as 50
- ✱✱ If we take the mean of the estimates this still means around 10 million other civilisations should be using radio to communicate.

The Fermi Paradox

- *^{*} The Fermi Paradox is a statement made by the physicist Enrico Fermi during a lunchtime conversation with his colleagues. They believed that there were a large number of intelligent and technologically advanced civilisations within our Galaxy.
- *^{*} If this is so the question is why is there no evidence that they have visited us and why have they not tried to contact us ?

The Answer to the Fermi Paradox

- ✱✱ Lots of discussions, some of which are summarised below !
- ✱✱ The numbers are wrong – there are few other civilisations
- ✱✱ We live in a ‘nature reserve’ and the galactic civilisations are not allowed to disturb us while we develop
- ✱✱ Technology only a few hundreds of years in advance of ours would seem like magic so we would not recognise them or their communications