

Notes Monday November 29th 2010

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### Vela Pulsar

- Vela pulsar was born 10,000 years ago at the center of a supernova and is a radio, optical, X-ray and gamma-emitting pulsar associated with Vela Supernova Remnant, in constellation of Vela
- The pulsar itself is a neutron star, formed as the stellar core was compacted to nuclear densities
- It has a strong magnetic field, approximately the mass of the Sun, and a diameter of about 20 kilometers, the Vela pulsar rotates 11 times a second
- At its core lies a "Pulsar", whose radio signal turns on and off about 11 times per second



[http://www.as.wvu.edu/~pulsar/phsurv\\_single/PLots1\\_files/Vela\\_Pulsar\\_jet.jpg](http://www.as.wvu.edu/~pulsar/phsurv_single/PLots1_files/Vela_Pulsar_jet.jpg)

### The Fermi Paradox

- The Fermi Paradox is the apparent contradiction between the high probability extraterrestrial civilizations' existence and the lack of contact with such civilizations
- Any civilization would inevitably end up seeking to spread itself beyond its planet of origin. One can quote three reasons for which this objective seems natural:
  - Exploration
  - Colonization
  - Survival
- Exploration consists of sending a mission towards other stars once the necessary technological level are reached
- Colonization as this is the underlining goal of most terrestrial civilizations since the beginning of times, for religious reasons as well as for economic or political reasons
- Survival- The lifespan of a star in a stable form is limited and It will one day become a red giant and absorb all planets, space flights and interstellar flights will prove to be essential to the humanity's survival

## The Drake Equation

- The Drake Equation was developed by Frank Drake in 1961 as a way to focus on the factors which determine how many intelligent, communicating civilizations there are in our galaxy

The Drake equation states that:

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

where:

**N** is the number of **civilizations** in our galaxy with which we might expect to be able to communicate at any given time

and

**R\*** is the rate of **star** formation in **our galaxy**

**f<sub>p</sub>** is the fraction of those stars that have **planets**

**n<sub>e</sub>** is average number of planets that can potentially support **life** per star that has planets

**f<sub>l</sub>** is the fraction of the above that actually go on to develop life

**f<sub>i</sub>** is the fraction of the above that actually go on to develop intelligent life

**f<sub>c</sub>** is the fraction of the above that are willing and able to communicate

**L** is the expected lifetime of such a civilization

### **Historical values**

R\* = 10/year,

f<sub>p</sub> = 0.5,

n<sub>e</sub> = 2,

f<sub>l</sub> = 1,

f<sub>i</sub> = 0.01,

f<sub>c</sub> = 0.01,

and L = 10,000 years.

<http://www.fermiparadox.com/Fermi-paradox.htm>

$N = 10 \times 0.5 \times 2 \times 1 \times 0.01 \times 0.01 \times 10,000 = 10$  civilizations in our galaxy

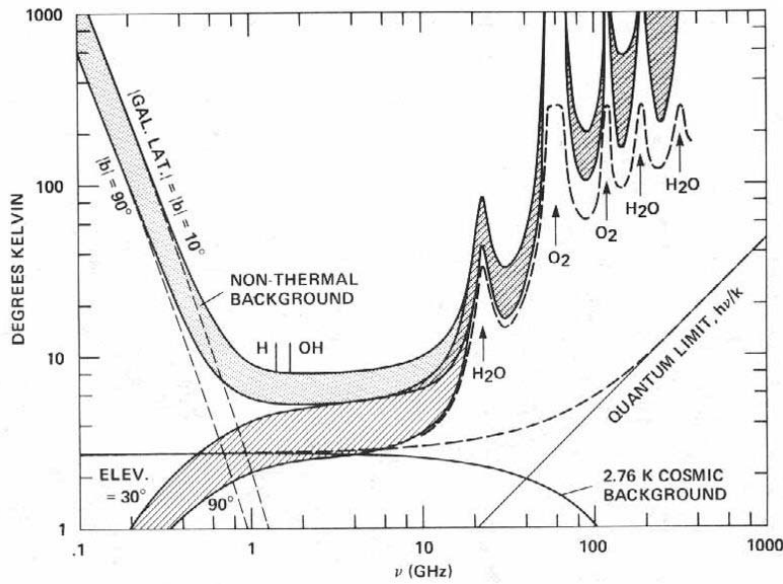
Based on current lower estimates:

$N = 6 \times 0.5 \times 2 \times 0.33 \times 1 \times 10^{-7} \times 0.01 \times 420 = 8.316 \times 10^{-7} = 0.0000008$  civilizations in our galaxy

- The results can vary widely, depending on the optimism of the numbers you yourself plug in

## Search for Extra-Terrestrial Intelligence (SETI)

- the collective name for a number of activities people undertake to search for intelligent extraterrestrial life
- SETI projects use scientific methods to search for electromagnetic transmissions from civilizations on distant planets
- Many radio frequencies penetrate our atmosphere quite well, and this led to radio telescopes that investigate the cosmos using large radio antennas
- one way of discovering an extraterrestrial civilization might be to detect non-natural radio emissions from a location outside our Solar System



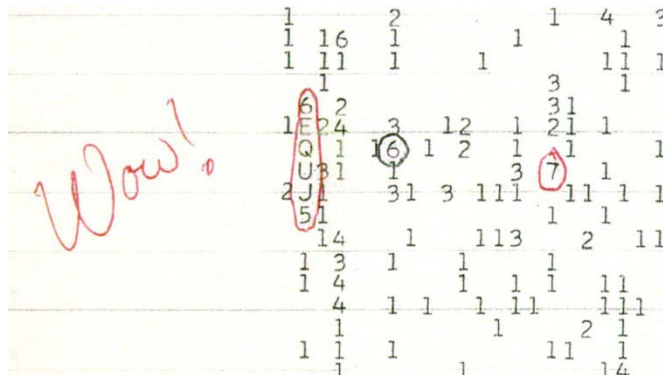
<http://upload.wikimedia.org/wikipedia/commons/f/fe/TerrestrialMicrowaveWindow.jpg>

### The Waterhole

- The waterhole refers to an especially quiet band of the electromagnetic spectrum between 1420 and 1666 Megahertz, corresponding to wavelengths of 21 and 18 centimeters respectively
- The strongest hydroxyl spectral line radiates at 18 centimeters, and hydrogen at 21 centimeters. These two combined form water, and water is currently thought to be essential to extraterrestrial life advanced enough to generate radio signals
- Bernard Oliver who coined the term theorized that the waterhole would be a good, obvious band for communications. Several SETI programs, including SETI@home, search in the waterhole

### Wow! Signal

- The OSU SETI program gained fame on August 15, 1977 when Jerry Ehman, a project volunteer, witnessed a startlingly strong signal received by the telescope. He quickly circled the indication on a printout and scribbled the phrase "Wow!" in the margin



[http://upload.wikimedia.org/wikipedia/commons/d/d3/Wow\\_signal.jpg](http://upload.wikimedia.org/wikipedia/commons/d/d3/Wow_signal.jpg)

- most likely candidate from an artificial, extraterrestrial source ever discovered, but it has not been detected again in several additional searches

### **Arecibo Observatory**

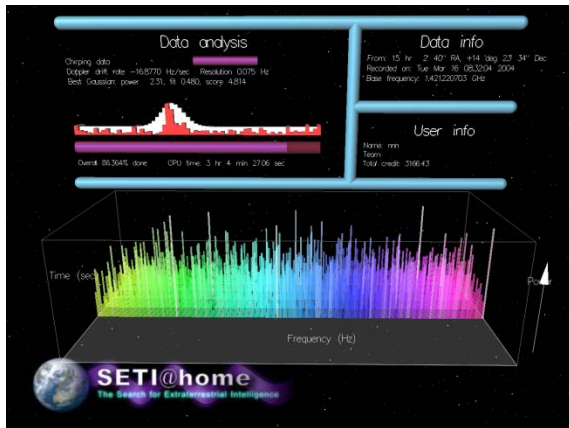
- It is the largest single-aperture radio telescope located close to the city of Arecibo in Puerto Rico
- The telescope received international recognition in 1999 when it began to collect data for the SETI@home project
- constructed inside the depression left by a karst sinkhole and its size gives it the largest electromagnetic-wave-gathering capacity



[http://www.knowledgerush.com/wiki\\_image/0/02/Arecibo.arp.750pix.jpg](http://www.knowledgerush.com/wiki_image/0/02/Arecibo.arp.750pix.jpg)

### **SETI@home**

- It's a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI).
- The software searches for four types of signals that distinguish them from noise:
  - Spikes in power spectra
  - Gaussian rises and falls in transmission power
  - Triplets – three power spikes in a row
  - Pulsing signals that possibly represent a narrowband digital-style transmission



<http://upload.wikimedia.org/wikipedia/commons/7/70/Setiathomeversion4point45.png>

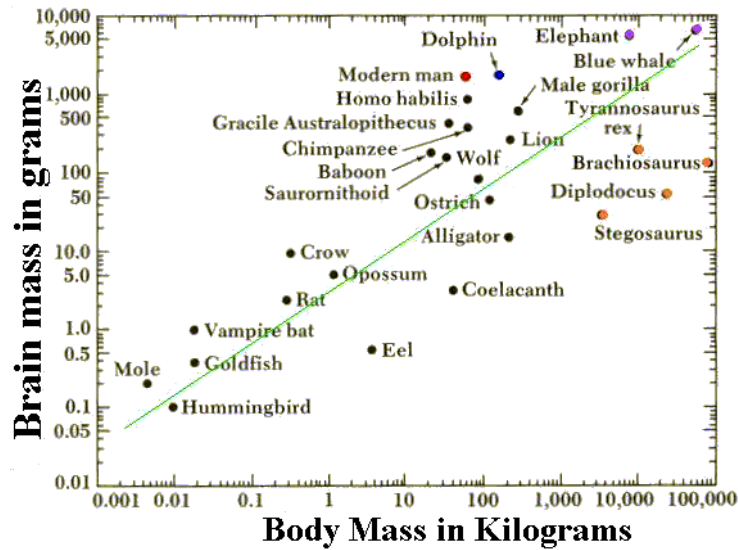
- Observational Data are recorded on 36 Gigabyte tapes at the Arecibo Observatory in Puerto Rico, each holding 15.5 hours of observations, which are then mailed to Berkeley. Once there, it is divided in both time and frequency domains *work units* of 107 seconds of data. These work units then get sent from the SETI@home server over the Internet to personal computers around the world to analyze

## Intelligence

- How do you measure Intelligence?
- Are humans only intelligent?

### **Brain-to-body weight ratio**

- A rough estimate of the possible intelligence of an organism. It can be defined as the ratio of the actual brain weight to the expected brain weight of a typical animal that size
- Humans have a higher brain-to-body weight ratio than any animal
- But Neanderthals had a bigger brain than us yet we were more intelligent



<http://www.archure.net/p/bbbGIF.gif>

### Organization of the Brain

- The cerebral cortex is the part of the brain that most strongly distinguishes mammals from other vertebrates, primates from other mammals, and humans from other primates

### intelligence quotient

- **IQ**, is a score derived from one of several different standardized tests designed to assess intelligence
- Environmental factors play a role in determining IQ. Proper childhood nutrition appears critical for cognitive development; malnutrition can lower IQ