

Ooga Booga *An Exploration in Active SETI*

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Introduction

This poster aims to provide the reader with interesting ideas regarding how we may communicate with extraterrestrial intelligence. It is inspired by Vsauce's *Messages For The Future*[1] in which Michael Stevens discusses both objects and signal, ejected into space for any to stumble upon, whether as a relic of Earth or a map to our civilisation. Finally, should the linguistics and logic take your fancy, the following is an interesting puzzle: martinmartin.com/seti-puzzle

The Pioneer Plaques - 1972, 1973

The first man-made object with a trajectory out of the solar system was the Pioneer 10 interstellar probe, launching in 1972. It was followed by the Pioneer 11 in 1973. On both probes, there are identical plaques for any life that may intercept them. Designed by Carl Sagan and Francis Drake, the two plaques display a few basic measures, a greeting from humankind and a map to Earth. On the plaques, there are:

- time and distance measurement definition. This is done using a hyperfine transition of neutral hydrogen. Hydrogen is the universe's most abundant element. In its neutral state, the proton and electron spins are 180 apart which is shown on the left of the diagram. On the right, there is a hydrogen atom with the proton and electron spin 0 apart. Transitioning between these two states gives a frequency of 1420MHz which corresponds to a period of approximately 0.704ns. Light at this frequency has the wavelength of 21.106cm in a vacuum. Between the two is a line with a vertical dash underneath indicating the number one in binary. This is one of the standard units used for time and distance on the plaques.

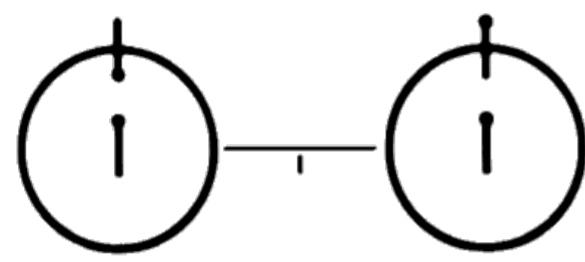


Figure 1: Hyperfine transition of neutral hydrogen used for time and distance measurement.[2]

- figures of a scale man and woman in front of the probe. Next to the woman is a pair of brackets that highlight her height (not shown below). Between the brackets is the binary number for eight. Eight units are roughly equivalent to 168cm. To assist others with reaching this conclusion, the probe is behind the people so there is a physical indication to the size of humans and the number system used.

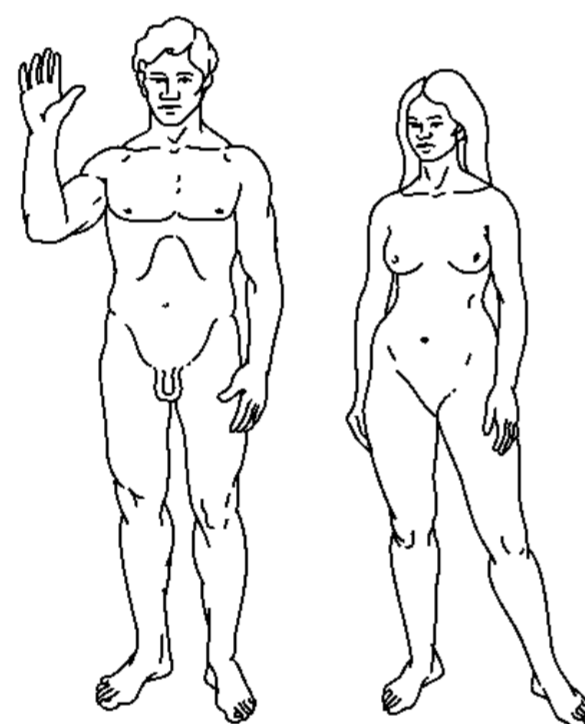


Figure 2: Male and female human in the nude.[2]

- directions to our solar system. The diagram displays fifteen lines from a point that represents the centre of the galaxy. One line points towards the humans previously mentioned. The other lines point toward pulsars showing distances from the centre of the galaxy compared to our distance to the centre of the galaxy. At the end of each line is a binary string indicating the period of pulsars using the hydrogen spin flip frequency as the unit.

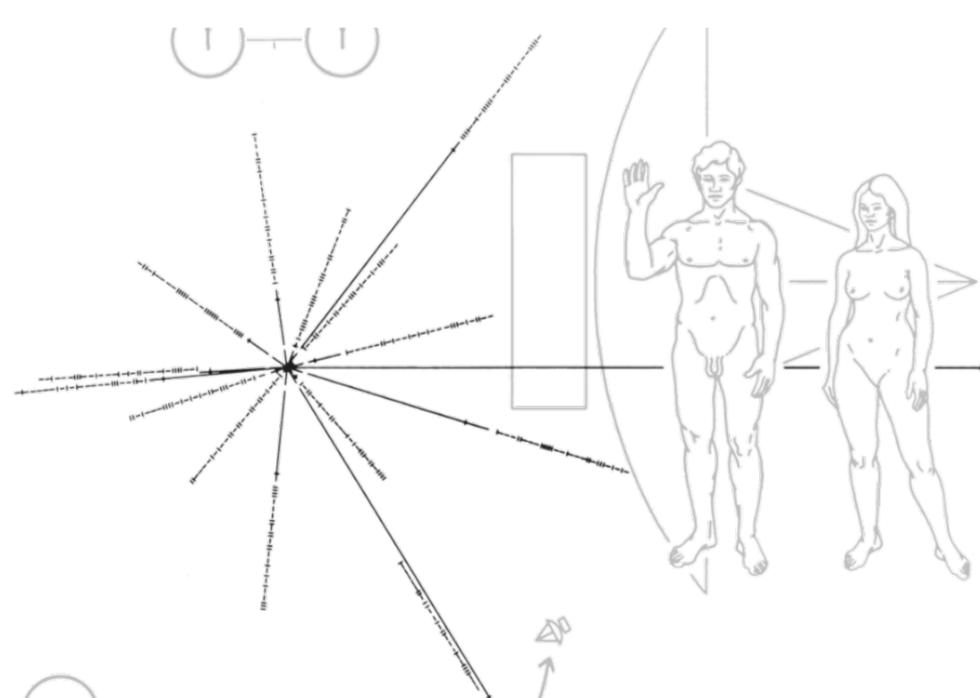


Figure 3: An interstellar map to Earth based on the position of pulsars.[2]

- the solar system. The sun and planets are shown in a line with an arrow showing the Pioneer 10's trajectory. Each planet's distance from the Sun is indicated in terms of tenths of Mercury's distance to the Sun.

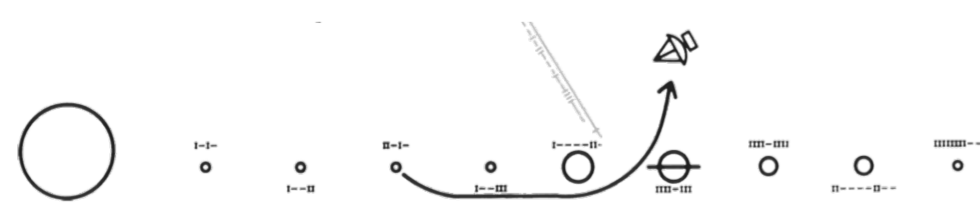


Figure 4: A map of our solar system, including the Pioneer X's trajectory.[2]

To protect the plaque from wear, it was installed on the probe under cover. This shields it from space dust to reduce the effect of erosion. Additionally, it is made from gold-anodized aluminium. Gold is unreactive meaning it will last longer than other common materials. By using a thin layer of gold, production is made cheaper.

The Arecibo Message - 1974

The Arecibo Message was the first interstellar radio message. According to Donald Campbell, a professor of astronomy at Cornell University, it was a strictly symbolic event it showcased technological achievement.[3] This is furthered by the fact that the globular cluster it was aimed at, M13, will have moved significant distance by the time that the message arrives.[4] It is important to clarify that this message not transmitted as an image but instead a series of blips of radio signal. Specifically, there are a biprime number of bits $1679 (23 * 73)$ so that there is less ambiguity for the discoverer of the radio signal as to its intended interpretation.[6]

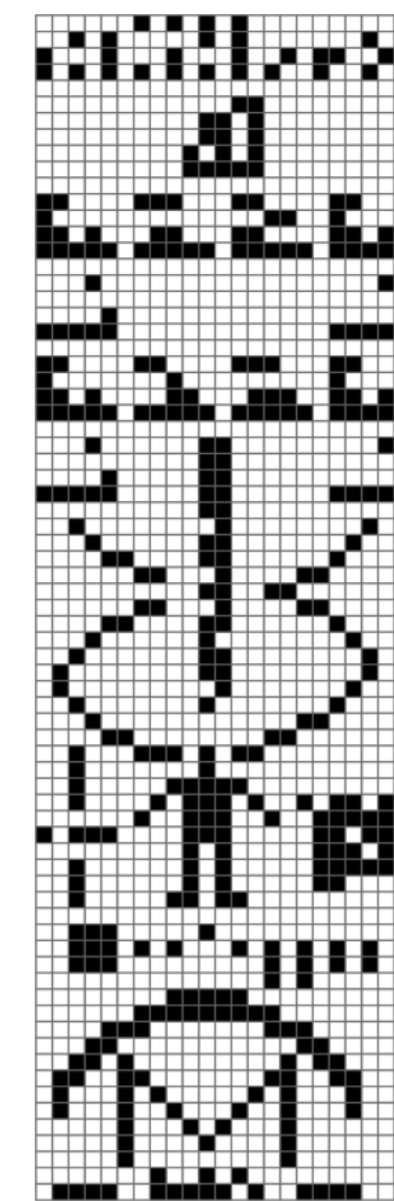


Figure 5: The Arecibo Message as meant to be read.[5]

The top four lines of the message represent the binary numbers 1-10. The fourth line is used to show where the least significant bit is. The next blob is a series of numbers which represent the atomic number of the elements that DNA (Hydrogen, Carbon, Nitrogen, Oxygen and Phosphorus) in binary. Following this are the nucleotides which are molecules that are the building blocks of DNA. Each one of the nucleotides is represented here by a string of numbers corresponding to how many of each element produce that specific nucleotide. The double helix of DNA then trails down both sides of a number representing the believed number of base pairs in DNA (roughly 4.3billion). There is then a picture of a bar next to a human. The bar represents the height of the human and has the number 14 in its middle, meaning, this human is 14 units tall. Here, the units are the wavelength of the radio message (approximately 12.6cm). To the right of the human is a block which represents the human population in 1974. This is again roughly 4.3billion which is coincidentally close to the number of DNA base pairs mentioned above. Beneath this is an image of our solar system. Earth is raised to show its significance. As well as this, the human is standing directly above it. There is also an indication of planet scale with Jupiter and Saturn having additional weight in the image. At the bottom of the image is the Arecibo Observatory along with a line to represent its diameter and the number 2430 in binary. This is measured in the radio wavelength as well.

LAGEOS 1 - 1976

LAGEOS 1, one of twins, is a satellite orbiting Earth which was launched in 1976. Aboard the satellite is a plaque designed by American astronomer, Carl Sagan. This plaque is no message for ETIs; it is a time-capsule. In orbit around Earth, satellites are unlikely to be affected by catastrophe on Earth. Because of this, durable materials and a planned orbit, it is expected to re-enter Earth's atmosphere in approximately 8.4million years.[7]

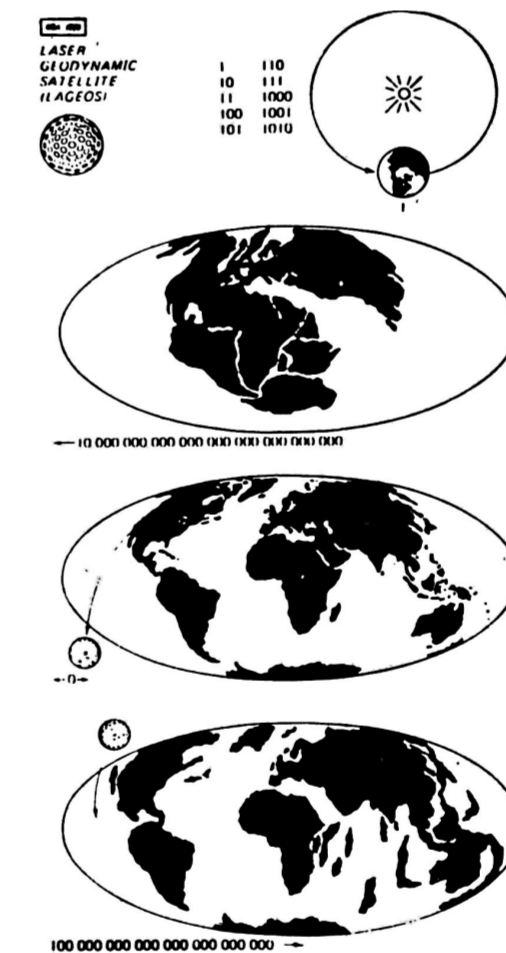


Figure 6: The LAGEOS plaque's engravings.[8]

The message is a thin steel plaque wrapped around the cylindrical core of the satellite.[9] To access it, you would need to crack open the satellite. The message itself shows the numbers 1 through 10 in binary, using arabic numerals. It also shows the orbit of the Earth around the Sun and assigns this a value of 1 so that base unit is years. There are three maps of Earth's surface at different points in time, respectively: roughly 268million years ago, 1976 and roughly 8.4million years in the future. The latter two feature LAGEOS 1 entering orbit and falling to Earth.

Lincos & Cosmic Call 1 - 1999

Lincos is a conlang (constructed language), constructed by Dr. Hans Freudenthal. It was first released in his 1960 book of the title *Lincos: Design of a Language for Cosmic Intercourse, Part 1*. [13] There shall be no Part 2 due to the author's passing. The conlang was created for radio transmission with the goal of being interpretable to any intelligent life. To understand any message within the language, you must read a series of standard, initial messages. The messages start with blips corresponding to the natural numbers in unary (2 blips corresponds to the number 2). This is followed by many binary operations and comparisons. Given multiple of these statements, it is possible to deduce the meaning of the operations and comparisons. This mathematics leads to more complex logical statements. Through the rest of the book, concepts such as time, space and desire are introduced. Concepts, such as desire, are introduced through fictional conversation. Finally, the book goes as far as to describe the physical features of a human. This was first applied in 1999, when astronomers Dutil and Dumas encoded a message into Lincos and broadcast it to neighbouring stars. This message contained a greeting, discussion of mathematics and science, a formal request for a response and the information of 2,000 people who paid to be included in the message. [14][15] This message differed from The Arecibo Message in that it was far larger (300,000 bits versus 1,679 bits). Far more information was contained but there was also a lot data redundancy so that should information be lost to noise, the message should remain entirely intelligible. This would not be the case for The Arecibo Message. [14] Innovatively, the message was designed in a noise resistant format.

Teen Age Message - 2001

The Teen Age Message were a few radio messages sent from the Crimean Yevpatoria Planetary Radar. Between August 29th-September 4th, 2001, seven messages were broadcast towards constellations and clusters throughout the galaxy. It was the first musical Active SETI transmission. [16] Alexander Zaitsev, Russia's SETI League Regional Coordinator, believed art should be the focus of CETI (communication with extraterrestrial intelligence) as they presumably know about mathematics and physics but our art is unique to us. [17] The messages consists of three components: a sounding, a live Theremin instrument concert and some digital information. The sounding stage is ten minutes of monochromatic wave with Doppler correction for the Earth's rotation around the Sun and the Earth's axial rotation. This will assist the receiver in correcting the next stage of the message. The next stage of the messages were 15-minute-long live Theremin instrument concerts performed by teenagers. This instrument was chosen for its simple waveform. The final stage is a binary signal which contains greetings in Russian and English, simple images of Earth-related things and TAM's (Teen Age Message) logo. [18]

Bibliography: pastebin.com/Ss6UJJRn