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Connecting earthlings: from peace cranes to the Arecibo message.

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Abstract

Ten million paper cranes are offered each year to the Children Peace Monument in Hiroshima, Japan. Origami has the power to connect earthlings who don't speak the same language. The Arecibo message has been broadcast to space in 1974. It remains a good tool for education in STEM and can be seen as a peace message. Every human is represented from a cosmic perspective by what we have in common: counting in base 10, our DNA, our form and the planet we live on. The Arecibo message can be reproduced using the pixel origami technique. This interactive tutorial presents a 2022 update of the message.

Keywords: SETI, Origami, Arecibo, Peace, Education

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Acronyms/Abbreviations

Communication with Extraterrestrial Intelligence (CETI)

Messaging to ExtraTerrestrial Intelligence (METI)

Search for Extraterrestrial Intelligence (SETI)

Science, Technology, Engineering and Mathematics (STEM)

1. Introduction

1.1 World war II and Hiroshima Peace crane

The length of a technological civilization is discussed since the cold war. The bombing of Hiroshima and Nagasaki in 1945 occurred just after the discovery of radioastronomy by Carl Jansky in 1933.

The story of Sadako is used to promote peace around the world and to let the children speak about grief [1]. Ten million paper cranes are offered each year to the Children Peace Monument in Hiroshima.

1.2 Cold war and SETI

Scientists have tried to collaborate during the cold war. Searches on extraterrestrial civilizations have been conduct in USSR [2]. To face the soviet restriction on translations Shklovsky famous book "Universe, Life, Intelligence" published in Moscow in 1962 [3] has been co-authored by Carl Sagan to be available in the rest of the world in 1966. The first US-USSR CETI conference has been organized in Byurakan, Armenia in 1971.

1.3 SETI & Origami as a vector of Peace & Education

Education in peace and in STEM could be a key factor for the survival of earthlings on this planet. The question "Are we alone in the universe?" is asked by preschool children as well as by elderly people. Bamboozled people rejecting science can listen to an astronomer speaking about the search of extraterrestrial civilizations.

Origami teaches patience and method [1]. One has to follow a video tutorial or a written schema step by step to achieve the model.

The Declaration of Principles Concerning Activities Following the Detection of Extraterrestrial Intelligence [5] is useful to react to claims about *mysterious signals* on social networks or press headlines. Like origami folders, scientists have protocols to follow.

1.4 Messages for earthlings

Do we have to send a cosmic message? What should we say? Who could speak in the name of mankind? A lot of ethical questions arose after each broadcast. The debate about the Pioneer plaque lasts for more than 50 years. Alexander Zaitsev has created the METI acronym in 2005 [6] and always been an advocate for messaging to extraterrestrial intelligence [7].

Even if we are alone in the universe those cosmic calls are received by humans. Most of them depict what all earthlings share: mathematics, science, music, arts, etc…

In 1974 a message was sent from Arecibo to test the new radar installed. When Franck Drake sent it to several scientists, none was able to decode it entirely, but each one could identify the part within its expertise. Some update are needed. The number of human is not the same in 2022 and 1974. There was also some mistakes such as the number of planets in the solar system or the number of nucleotide.

Whereas some authors propose to send a new Arecibo message from the FAST radio telescope [8], the old 1974 Arecibo message can be used as a peace vector and for education in STEM.

2. Material and methods

2.1 Origami

The 1974 Arecibo message is built with pixel unit as fold by S. Gigandet [9]. Other models could have been used but they are more complex [10].

Any sheet of paper can be used to obtain a square. Superposing the two continuous sides of an A4 paper and cutting the remaining part is a way to recycle scholar documents.

The length of a pixel is the length of the original paper divided by $\sqrt{2}$. The origami technic answers to arguments such as "I've never used Pythagorean theorem in real life".

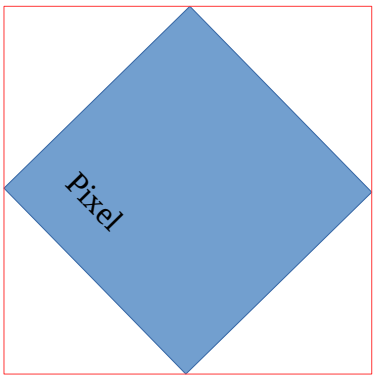

Fig. 1.: Original paper (red) and pixel (blue)

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The Arecibo message is composed by 1,679 digits. 1,679 is a semi-prime number. The digits can be arranged in a 23x73 array.

If the size of the original paper is too big, the final message will be huge.

For instance, with a 21 x 21 cm paper square, a pixel has a width of 14.8 cm and the final message is 3.41m x 10.83m.

If the paper is too small, the link between pixels will be less solid.

With a 4.5cm paper square the message has a width of 73 cm and a length of 2.32 m.

2.2 SETI for education

People rejecting science can be interested by life in the universe. Astronomers and scientists looking for life in the universe have been precursors on climate warning few decades ago. The search of exoplanets and the big headlines when a twin of Earth is discovered show how fragile is the receipt for an ecosystem.

Many SETI conferences have invited young people to listen and ask questions. Non profit organizations such as the SETI League have young members building stations or asking questions to Dr SETI.

What does "Fourier Transform" mean? The SETI@HOME project was a chance to see earthlings work and learn together. In 2017 there was 1,685,168 users from 133 countries.

Scientists like Carl Sagan have used the search for technosignature to increase the public interest for astronomy and to encourage rationalism.

How to code and decode a message? What to say? How will I introduce myself to an alien? Such questions can be a way to introduce math and computing as a game.

The education center is an important part of the Arecibo Observatory. After the collapse of the cable in 2020, education and public outreach went on. In 2019, to celebrate the 45th anniversary of the iconic Arecibo Message, the Arecibo Observatory (AO) has invited inter-generation, diverse and international teams of student to propose an updated message. [11]

The 1974 Arecibo message can be understood by everybody. According to the knowledge and the age of the student, details can be given. The first lines represents numbers from 1 to 10 (Fig. 2.). This information can be sufficient for most people.

Why 10? Why do we count in base 10? Would an alien with 2 hands of 4 fingers count in base 8?

Binary number can be introduced as a game. If you could onl use “0 and 1” how would you count? 0, 1, 10, 11, 100, 101, 110, etc…

3. Numbers

The use of mathematics by METI has often been criticized. Few people understand complex equations and some students are anxious or face maths phobia.

Most culture on Earth used geometry or symmetry in paintings, sculptures or clothes. You don’t need to master trigonometry to fold origami but it helps to understand how to obtain right angles or hexagons.

3.1 Human height

The human height is represented in binary by 0111. This is 14 in base 10.

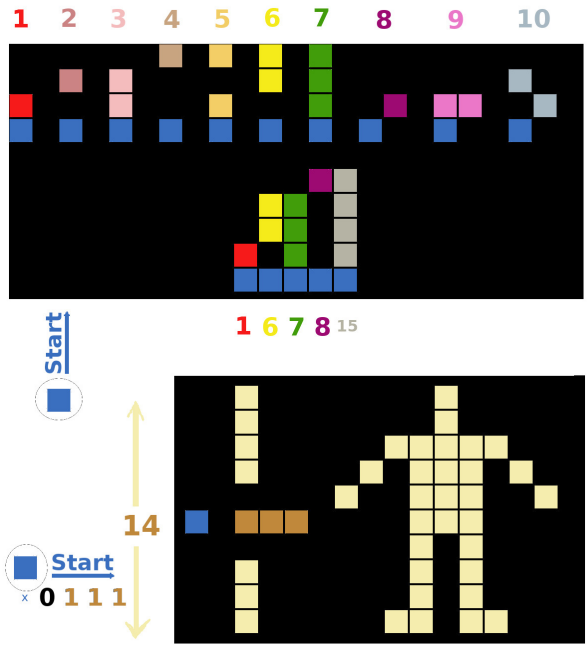

Fig. 2 : numbers in the Arecibo message.

The message was broadcast at the 126 mm wavelength. The product of 14 and this length gives the height of the human. The diameter of the antenna at the bottom of the message is also given with the same multiplication.

14 × 126 = 1,764

1.76m was the average height of a man in the USA in 1974.

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3.3 Number of nucleotide

The shape of DNA double helix can be easily identified. In the middle the number of nucleotids is represented.

In 1974 the number was 4,294,441,822.

Today it is estimated that there's 3,088,286,401 base pairs in the human genome. The message would have to be updated as in Fig. 3.

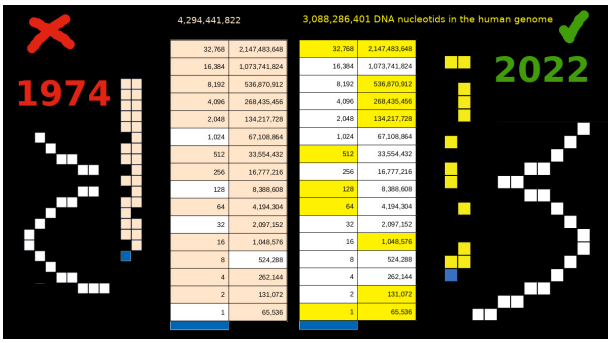

Fig 3: number of nucleotids

3.4 Human population

On the February the first 2022, there was 7,924,993,495 humans on Earth.

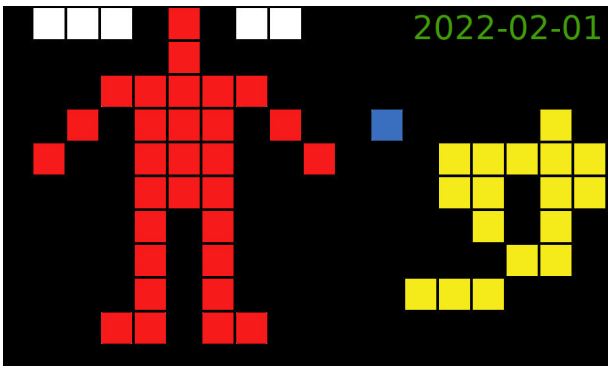

Fig. 4. Update of the earth population.

When the message was sent in 1974, the Earth population was 4,292,853,750.

4. Result: the 2022 Arecibo message

Once the number of nucleotide and the human population updated, we also have to remove Pluto from the solar system. The corrected Arecibo message will look as in Fig. 5.

If the update version is sent by FAST radio telescope in China, the drawing of the antenna stays correct. The last lines represent the size of the spheric mirror. It will need some updates.

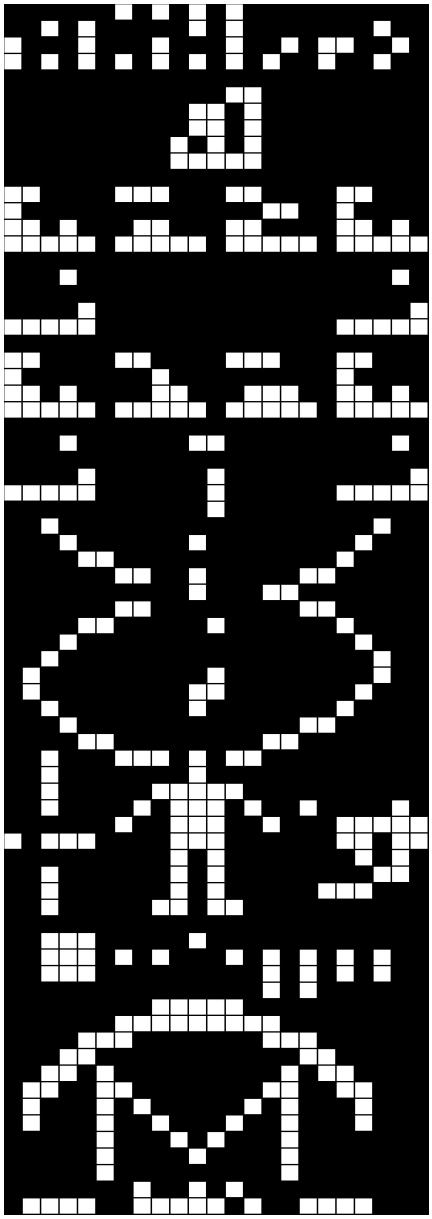

Fig. 5. The 2022 Arecibo message.

5. Discussion

The 1974 Arecibo message was conceived by an American man. An other human being would agree on the chemistry, the DNA but could wish a change on the size of the human. For instance choosing 13 instead of 14.

13 x 126 = 1,638

Mahatma Gandhi was 1.65m height (Fig. 6.).

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The average height of a women in France is 1.639m

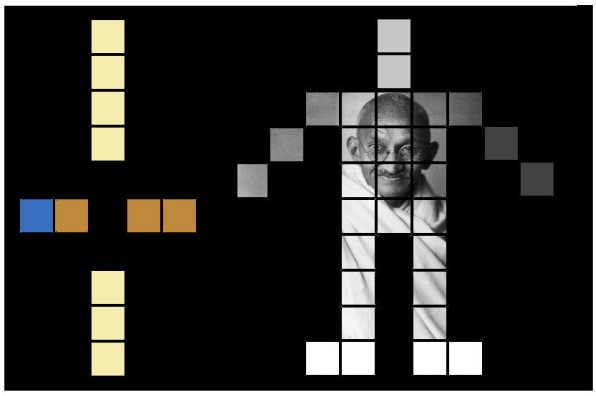

Fig.6. Size of Mahatma Gandhi

The Arecibo message can be understood at different levels by every human. None of us could decipher it alone without explanation.

The differences between 1974 and 2022 come from a better scientific knowledge. It shows humanity's progress in astronomy and genetics.

The increase of the Earth population is linked to the environmental challenges we face.

6. Conclusion

The Arecibo message is symbolic and technical. It has been used in STEM since 1974. It's a picture of what we were, what we knew about ourselves and our place in the universe at those times.

The cosmic perspective is a key factor for peace. If we want our civilization to live longer we have environmental challenges to solve. We are facing the nuclear threat since 1945 and the bombing of Hiiroshima. Around the world people sent million paper cranes to the Children Peace Museum each year. Non proliferation treaties have been signed. Meanwhile scientist form the east and west have searched for technological signatures.

Discussing messages such as the one sent in Arecibo is a first step to see what all human have in common. It's also a lesson of humility. We made mistakes. We need to update the number of planets in our solar system or the earth population.

Even if we are alone in the universe, those messages received by all the earthlings could act for peace and for longer civilizations.

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