4-18-2008

Connections to the Cosmos: the search for life beyond Earth

Shane L. Larson
Utah State University

Follow this and additional works at: https://digitalcommons.usu.edu/astro_pubtalks

Part of the Astrophysics and Astronomy Commons

Recommended Citation
https://digitalcommons.usu.edu/astro_pubtalks/23
CONNECTIONS to the COSMOS: the search for life beyond Earth

Open House
18 April 2008
Weber State University

Shane L. Larson
shane@science.weber.edu

Open House
18 April 2008
Weber State University
• What are we talking about?
• What might life be like?
• Is there anyone to talk to? [SETI]
• How do we communicate? [CETI]
There are 100 billion galaxies, and a billion trillion stars, but this is the only world we know with life.

It is, as far as we know, unique in this regards.
Life in Harsh Environments

- We might despair of ever finding life elsewhere, considering the relatively hostility of the Universe.

- But if you look at life on Earth, we find life in unexpectedly harsh places: high acid, high alkalinity, high pressure, extreme dryness, extreme cold, extreme heat, extreme chemical activity...

- Lifeforms that live in extreme environments are called extremophiles. Most of them are microbic.
We might despair of ever finding life elsewhere, considering the relatively hostility of the Universe. But if you look at life on Earth, we find life in unexpectedly harsh places: high acid, high alkalinity, high pressure, extreme dryness, extreme cold, extreme heat, extreme chemical activity... Lifeforms that live in extreme environments are called extremophiles. Most of them are microbic.
We might despair of ever finding life elsewhere, considering the relatively hostility of the Universe. But if you look at life on Earth, we find life in unexpectedly harsh places: high acid, high alkalinity, high pressure, extreme dryness, extreme cold, extreme heat, extreme chemical activity...

Lifeforms that live in extreme environments are called extremophiles. Most of them are microbic.
Life in Harsh Environments

- We might despair of ever finding life elsewhere, considering the relatively hostility of the Universe

- But if you look at life on Earth, we find life in unexpectedly harsh places: high acid, high alkalinity, high pressure, extreme dryness, extreme cold, extreme heat, extreme chemical activity...

- Lifeforms that live in extreme environments are called extremophiles. Most of them are microbic.

- There are 6,000,000,000 humans on Earth; together we mass about 100 million tons

- There are 5,000,000,000,000,000,000,000,000,000,000,000 bacteria on Earth; they mass 2 billion tons (20x human race)
What we consider to be “life processes” is different in different environments.

Outside your front door, plants photosynthesize – convert carbon dioxide to energy using sunlight.

Around black smokers, organisms chemosynthesize – convert methane and sulfur into energy using heat.

Acidophiles (pH < 3) produce modified proteins that are acid resistant.

Some halophiles (high salt content) manage salt through absorption of atomic ions.
We know of no known examples of life off of Earth.

Tantalizing evidence in a Martian meteorite found in Antarctica (ALH84001)

- Fossilized bacteria?
- Still much debate

Possible example of panspermia – seed life spreading from world to world (e.g. by asteroid impacts)

Microbes, microbes. What about aliens like us?
We have often imagined aliens...
Frank Drake proposed an equation to estimate the number of civilizations we could communicate with in the Universe.

Estimate 7 numbers, and multiply!

**PESSIMISTIC:** 1 civilization

**OPTIMISTIC:** 50 civilizations
The distances in the Cosmos are vast – communicating is a long term proposition.

There are many obstacles!

- Broadcasters have to get the signal noticed!
- Listeners have to interpret the signal!

Use radio telescopes to send digital messages.

Use mathematical principles and astrophysics quantities.
The distances in the Cosmos are vast – communicating is a long-term proposition.

There are many obstacles!

Broadcasters have to get the signal noticed!

Listeners have to interpret the signal!

Use radio telescopes to send digital messages.

Use mathematical principles and astrophysics quantities.
The distances in the Cosmos are vast – communicating is a long-term proposition.

There are many obstacles!

Broadcasters have to get the signal noticed!

Listeners have to interpret the signal!

Use radio telescopes to send digital messages.

Use mathematical principles and astrophysics quantities.
In 1974, we sent a message consisting of 1679 digits toward the globular cluster in Hercules (25,000 lyr away)
The Arecibo Message

What's that sound like?
The Arecibo Message

• The Arecibo Message is actually a digital image of sorts.

• **Mathematical principle:** there are 1679 digits. 1679 can be factored into two prime numbers:
  • $1679 = 23 \times 73$

• Take the digits, and make a picture grid which is either:
  • (23 tall and 73 wide) or (73 tall and 23 wide)
  • If you have a 1, shade in the grid square
  • If you have a 0, leave the grid square blank

• *Sometimes,* there is a primer, to help you find one of the prime factors, or to teach you how to read the message
The Arecibo Message

- The 23 tall x 73 wide doesn’t look like much:
The Arecibo Message

- The 73 tall x 23 wide looks like magic!
- How to count 1 to 10
- Numbers 1, 6, 7, 8, 15 (atomic numbers of hydrogen, carbon, nitrogen, phosphorus – atoms in DNA)
- DNA Nucleotides
- DNA Double Helix, number of nucleotides
- Human (height on left, population on right)
- Map of solar system
- Arecibo Telescope
The Arecibo Message

- The 73 tall x 23 wide looks like magic!
  - How to count 1 to 10
  - Numbers 1, 6, 7, 8, 15 (atomic numbers of hydrogen, carbon, nitrogen, phosphorus – atoms in DNA)
  - DNA Nucleotides
  - DNA Double Helix, number of nucleotides
  - Human (height on left, population on right)
  - Map of solar system
  - Arecibo Telescope
Each spacecraft carried a Golden Record about Earth, in case some civilization stumbles across our lonely spacecraft.

- Greetings in 55 languages
- 115 images of life on Earth
- 90 minutes of music – Earth's Greatest Hits

See the book Murmurs of Earth
• Each spacecraft carried a Golden Record about Earth, in case some civilization stumbles across our lonely spacecraft
  • Greetings in 55 languages
  • 115 images of life on Earth
  • 90 minutes of music – Earth’s Greatest Hits
• See the book *Murmurs of Earth*
Each spacecraft carried a Golden Record about Earth, in case some civilization stumbles across our lonely spacecraft.

Greetings in 55 languages

115 images of life on Earth

90 minutes of music – Earth’s Greatest Hits

See the book *Murmurs of Earth*

---

We cast this message into the cosmos… Of the 200 billion stars in the Milky Way galaxy, some — perhaps many — may have inhabited planets and space faring civilizations. If one such civilization intercepts Voyager and can understand these recorded contents, here is our message: We are trying to survive our time so we may live into yours. We hope some day, having solved the problems we face, to join a community of Galactic Civilizations. This record represents our hope and our determination and our goodwill in a vast and awesome universe.

~ Jimmy Carter

Greatest Hits

See the book *Murmurs of Earth*
• We can send, but we can also listen. Is someone out there sending messages to us?

• SETI is the ongoing search for signals from space.

• Limited by telescope time. It was once limited by computer analysis time, but seti@home has changed that.
Listening...

- We can send, but we can also listen. Is someone out there sending messages to us?
- SETI is the ongoing search for signals from space.
- Limited by telescope time. It was once limited by computer analysis time, but seti@home has changed that.
Last Thoughts...

- We are listening...
- We are sending...
- No one is talking to us yet...

Pick up a *Drake Puzzle Activity* to practice on your own!

Solution will be online with my talk next week at:
http://space.weber.edu/openhouse/talks/