

Is the Universe hostile to life?

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Astrophysics and Biology

- Last century was declared the century of Physics...
- This century is the century of Astrophysics and Biology
- These two disciplines seem to disagree on the Question: How common are other civilizations in the Universe?
- Recently they form a new interdisciplinary research area called "**Astrobiology**" .. to search for intelligent life in the universe...

Astrobiology

Astrobiology - the study of the origins, evolution, distribution, and future of life in the universe.

- A multidisciplinary approach incorporating molecular biology, chemistry, ecology, planetary science, astronomy, information science, space exploration, and related disciplines.
- Asks three fundamental questions
 1. How does life begin and evolve?
 2. Does life exist elsewhere in the universe?
 3. What is the future of life on Earth and beyond?

Astrobiology is Not Science Fiction



Goals of Astrobiology

- Understand the nature and distribution of habitable environments in the universe
- Explore for past and present habitable environments in the solar system
- Understand how life originates
- Understand how past life on Earth interacted with its environment



Goals of Astrobiology



- Understand evolutionary and environmental limits of life
- Understand the principles that will shape the future of life, both on Earth and beyond
- Determine how to recognize biosignatures on other worlds

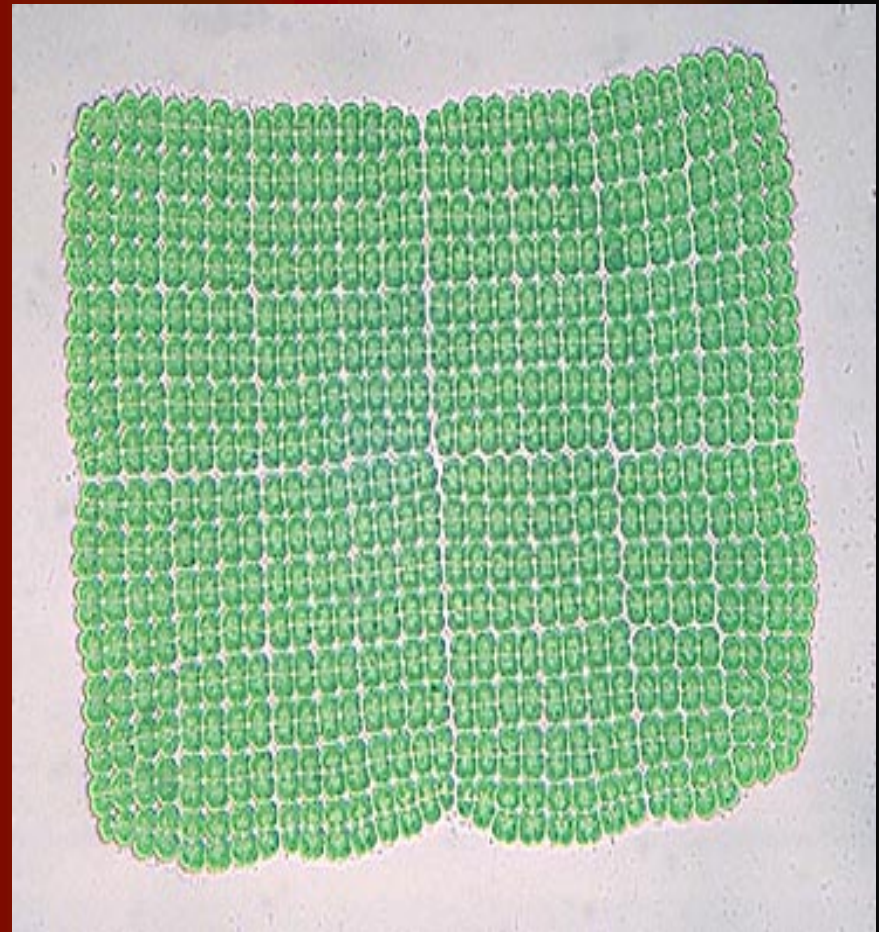
What is life?

Definition

A chemical system that undergoes Darwinian evolution and degrades high-quality energy from its environment in metabolism

Common Assumptions

Requires organic molecules and liquid water

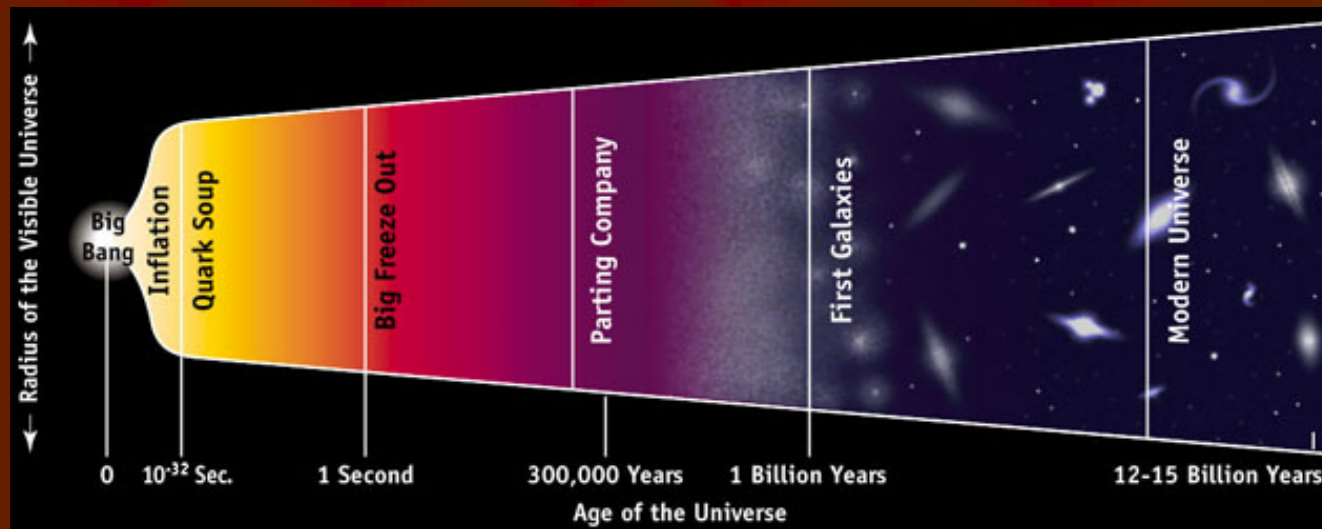


Is there Life Elsewhere in the Universe?

- The answer is: Nobody knows!
- Scientists' search for life beyond Earth has been less thorough than commonly thought.
- This fact is about to change.....
- The project of searching for life is extremely difficult and the probability for success is difficult to estimate, but if we never search, the chance of success is zero.

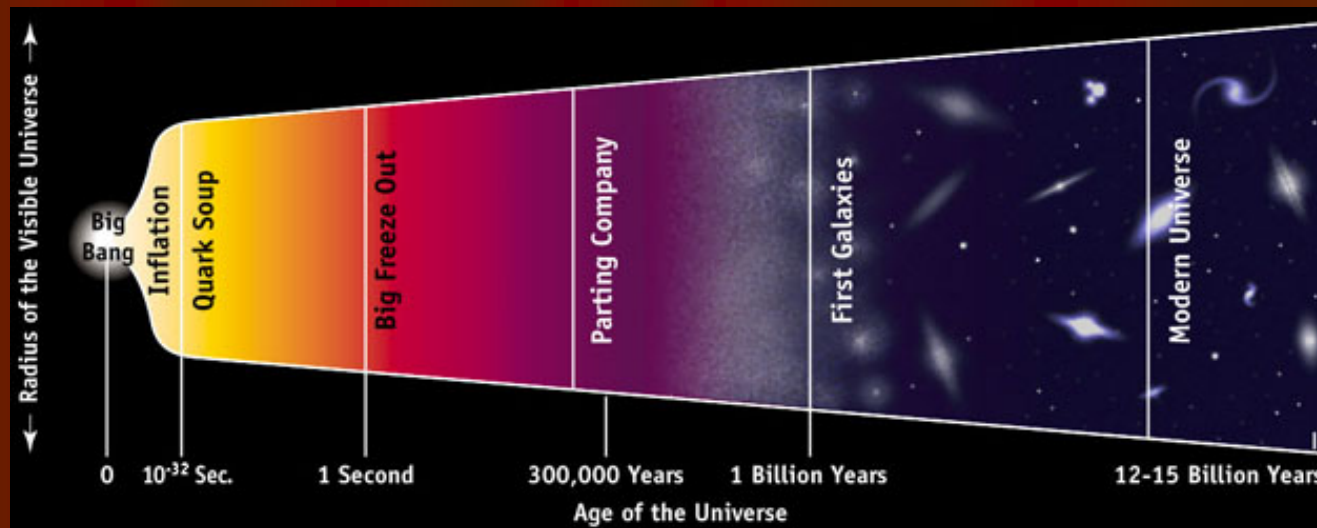
The beginning

- We believe today that the universe started with enormous matter and energy. This immense primordial energy was the bases were all life arose
- There was matter and antimatter and when they met, they annihilated each other, somehow matter was a tiny fraction more than antimatter. Matter and a billion times more light was left to continue.
- Only 4.4% of the mass and energy of the universe is contained in atoms. All life was made from a tiny portion of this 4.4%



We aren't made of Hydrogen

- The only chemical elements created at the beginning of our universe were Hydrogen, Helium and Lithium.
- If this was all life will never start. We are made of Carbon-based life forms. We are made and drink water and breath Oxygen. Carbon and Oxygen was not created during the Big Bang...



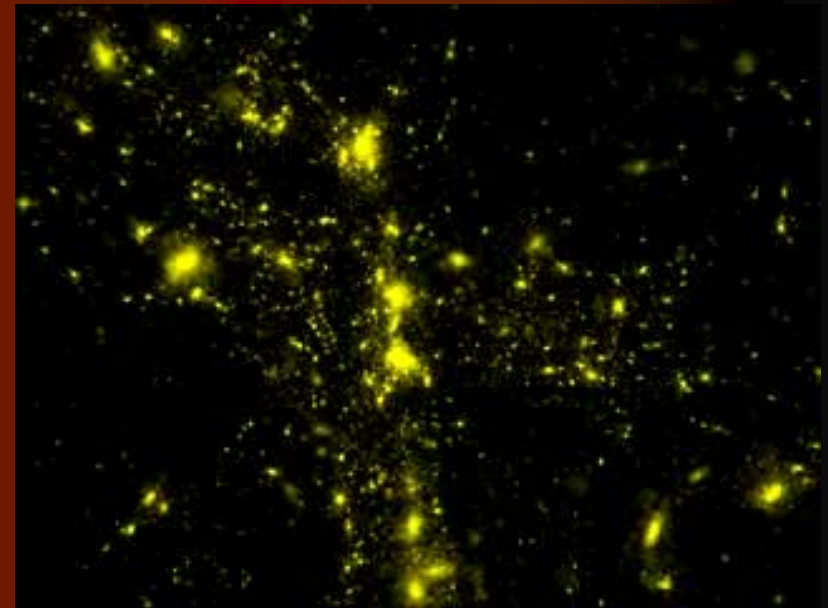
We are made from Star dust

- All of carbon and oxygen were made in all living things are made from in nuclear fusion reactors that are we call stars
- The first stars were massive and short lived. The consume H, He and produce heavier elements.
- When these stars die with a bang they spread the elements of life (Ca, O) throught the Universe. New stars condensate and new planets form from these heavier elements

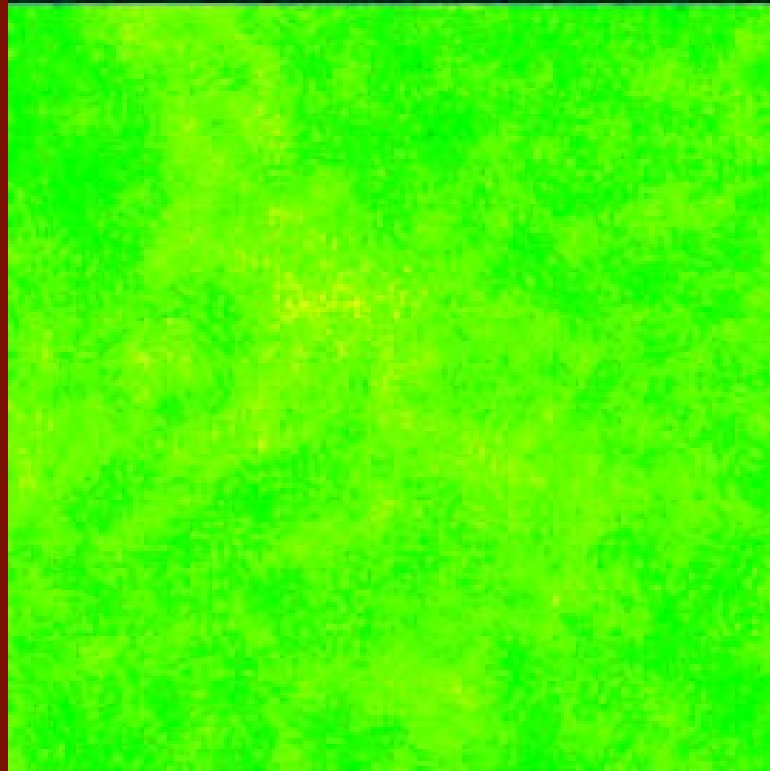


A journey inside today's Universe

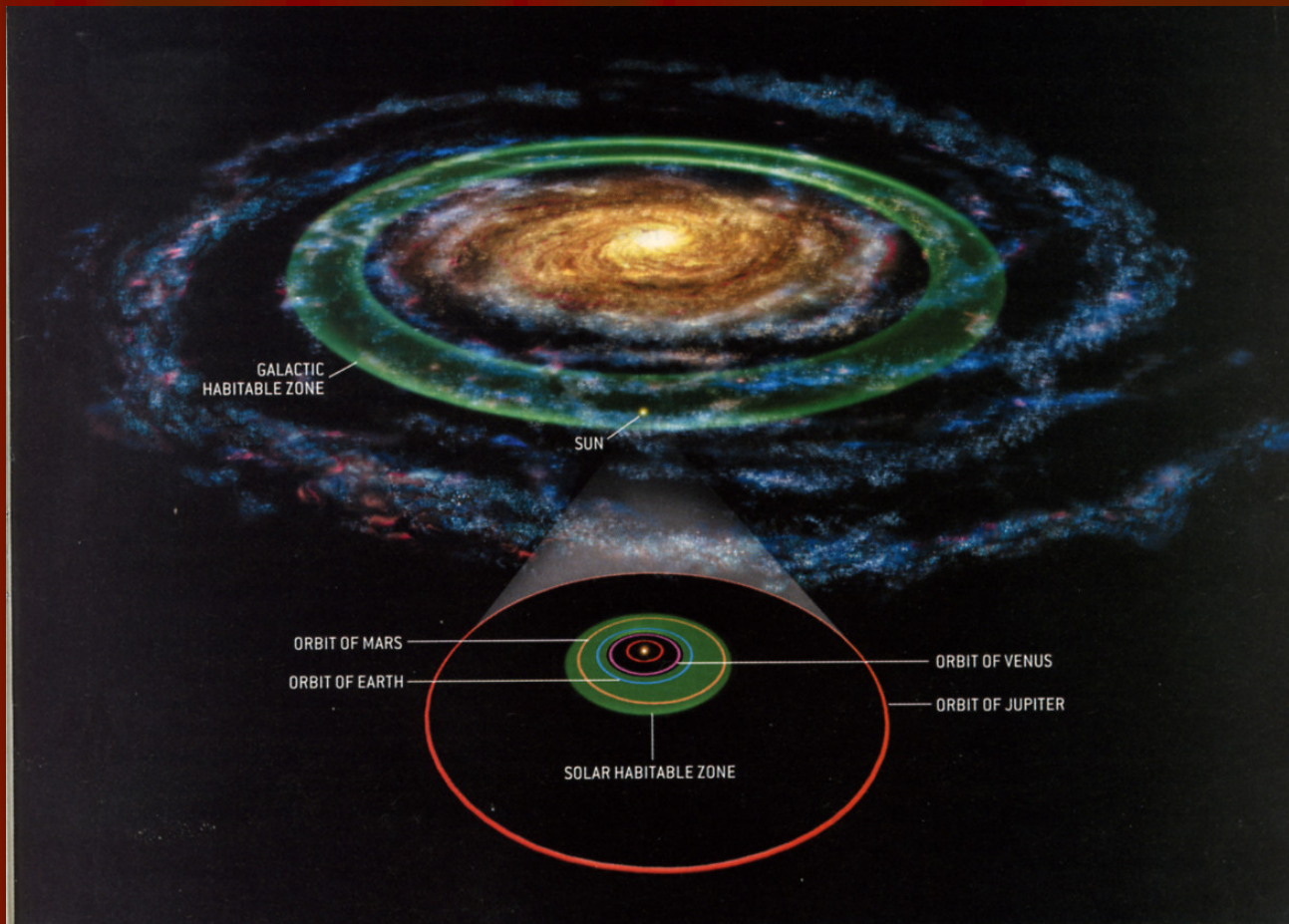
- The visible matter in the Universe is concentrated in strange multi scale structures (It has a fractal form).
- Most of the universe is empty...



How Clusters of galaxies and Galaxies are formed?



The Galactic and Circumstellar Habitable Zone



Planetary Formation

- Metals are the building blocks of Earth like planets. Without enough metals no giant planet can form at all, because they coalesce around a rocky core of a certain minimum size
- Size, in turn, determines if the planet can retain an atmosphere and sustain geologic activity.
- In the thin disk of our Galaxy the metallicity (ratio of metals/hydrogen) progressively decreases with the distance from the Galactic center
- Further away from the galactic center there is less gas and less prospects to form stars
- More dangers from impact by asteroids and comets and blast of radiation
- The inner regions of the galaxy suffer from high influx of radiation. From time to time the black hole sitting at the center of our galaxy pulls in to its death stars or clusters of stars resulting to burst of electromagnetic radiation.
- Gamma Ray Bursts and Supernovae in near the star can hold the formation of any life form in planets.

The Galactic and Circumstellar Habitable Zone

Globular Cluster M22



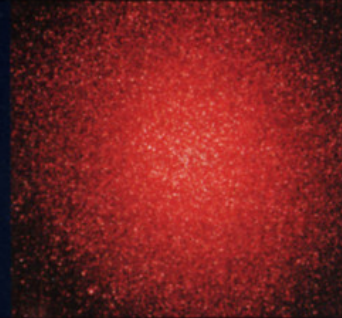
Few heavy elements

Eagle Nebula



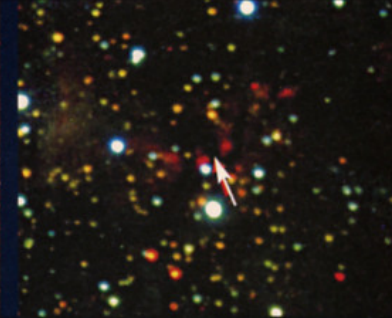
Being evaporated by giant stars

Globular Cluster Omega Centauri



Few heavy elements

O-type Star G339.88-1.26



Too bright, too short-lived

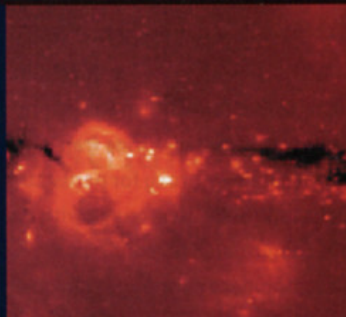
WHAT IS BEAUTIFUL is often dangerous, in space as on Earth. Some of the most renowned sites in the galaxy are hostile to planets, let alone living things. The safest places in the galaxy tend to be the most boring ones.

Trifid Nebula



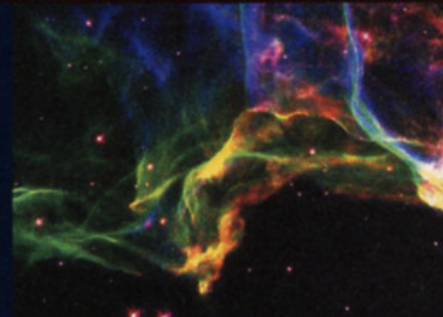
Ionized gas

Galactic Center



Intense radiation, unstable orbits

Cygnus Loop



Debris from stellar explosion

Proplyds in Orion Nebula



Being evaporated by giant stars

The Solar System

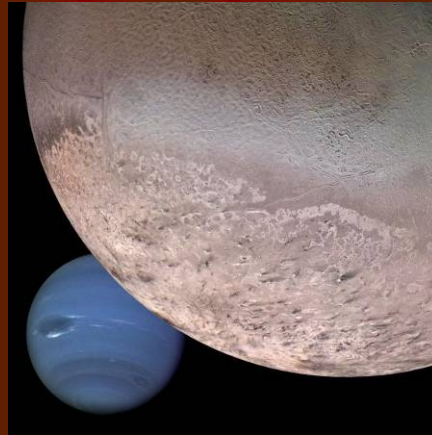


Where is there life?

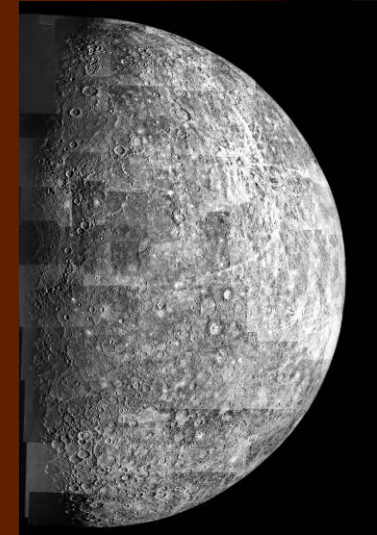
Other Possible Abodes of Life



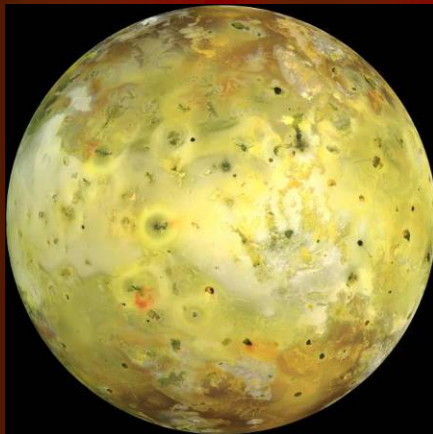
Enceladus



Triton



Mercury

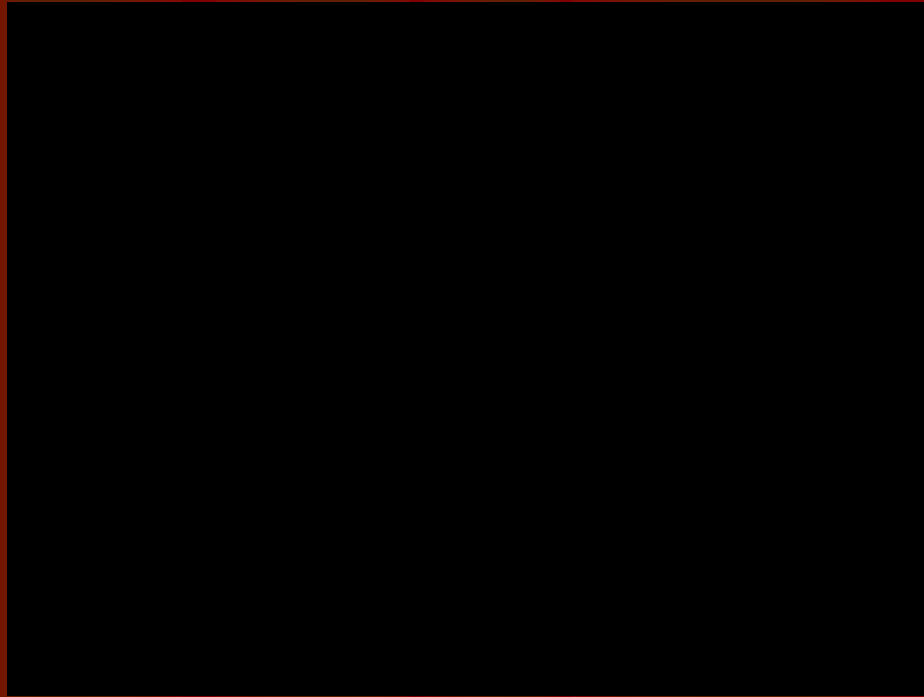


Io



Ganymede

Searching for life in other planets



A great debate between astronomers and Biologists

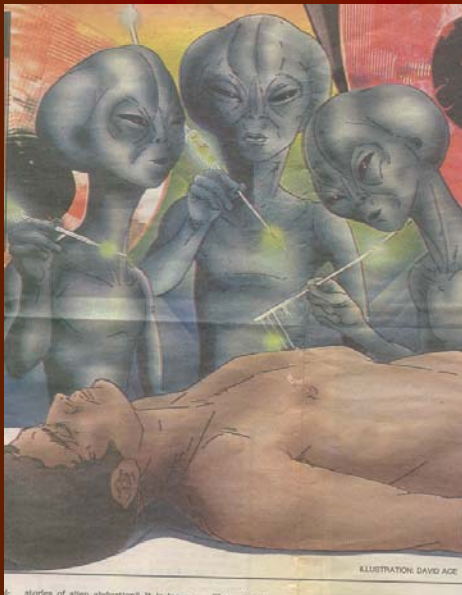
- Astronomers are optimistic and believe that complex and intelligent life is common in the Universe biologist insist that we maybe alone...let us see why.
- Everybody agrees that single cells are everywhere and may travel in rocks, so life in Earth may have come from another planet. Anexagoras was proposing something similar 2500 year ago and it was called Panspermia....Life was coming from simple seeds pervading the cosmos
- The differences start when we are discussing the existence of advanced forms of life....
- One question still is open is how far can living cells survive in a cosmic travel? Are there microorganisms resisting radiation and heat damage as they ride a meteorite?

A great debate between astronomers and Biologists

- Astronomers believe (using a famous but simplistic equation derived by Drake-Sagan) all you need is to be in the right place with the right star....and they are rising the number of the existing extraterrestrial civilizations to relatively high number inside our Galaxy (more than several thousands) but Biologists and Geologist add to this... a long list
 - Proper distance from the star
 - Proper distance from the center of the galaxy
 - A star of a proper mass
 - The planet must have the proper mass
 - Oceans
 - Constant energy output from the star
 - Successful evolution of simple life to multi cellular life
 - Avoiding disasters of any kind
 - The existence of Jupiter like planet in the system (attracts the asteroids)
 - The existence of large nearby moon (tilt stability)
 - Plate tectonics (stable atmosphere)

The weakest point of our theory...

- Are we looking for the right thing...
- Have we define life properly...
- Earthlike type life? Is this correct? or we are fooling ourselves again believing that we are the center of everything... is this very selfish...



Home sweet Home

- Any extraterrestrial civilization seeking a new world would place our solar system in their home-shopping list...
- We live in a prime real estate
- We should do all it is possible to preserve our planet.....

