

# Gaia (an Outline)

## a) History

- Once life appeared on Earth, in order for it to survive in the face of changing solar luminosity (temperature), conditions on Earth had to be regulated.
- In the early 1960s James (Jim) Lovelock was invited by NASA to come to the U.S. to help design two solar probes to Mars to explore the possibility of life. Jim is an expert of instrumentation as well as many fields of science.
- During the process of designing the probes he raised a very important question: If life on Mars is not like that on Earth, how can it be detected?
- The idea then struck that on Earth, where there is life, the atmosphere is in a very improbable state of disequilibrium - oxygen and methane (gases that can strongly interact) exist together, even after billions of years. Thus any planet that has "life" would have an atmosphere that has unusual and improbable chemistry.
- He proposed that it is not actually necessary to go to Mars, but that we can determine whether there is life on a planet by simply analyzing its atmosphere, using telescopes and analyzing the light.
- Venus and Mars have atmospheres with mostly non-reactive carbon dioxide, the "dead" gas that comes out the tail pipe of an internal combustion engine. They are "dead planets."
- Lovelock also understood that the atmosphere must have very carefully regulated concentrations of gases so that the temperature can remain within a critical limit (the cell wall is very delicate against temperature, salinity, acidity, etc.).
- But, just how could Earth so carefully regulate the chemistry and temperature?
- Lovelock came up with the idea that it is LIFE that regulates the planet so that it would be able to support and continue life.

## b) New definition of life

- According to Lovelock: **Life is a self-regulating system that maintains constant chemistry and temperature.**
- Life becomes linked - coupled - with the atmosphere, geology and oceans to maintain proper conditions for survival.
- This system came to be called "**Gaia**" (Greek goddess of Earth; suggested to Lovelock by author William Golding), and can be defined as:

**A self-regulating system with lifelike properties that maintains the necessary conditions for life.**

- Many people (especially biologists) challenged this idea, so Lovelock developed a computer simulation model, called Daisy World, by which he could prove that Gaia can self-regulate, as proposed.
- Think of a REDWOOD TREE and the EARTH SYSTEM. Very close similarities.
- Thus, on Earth after life got started, it COUPLED with the atmosphere, oceans and geology to form a tightly coupled system.

## c) Conclusions:

- In this system the earliest forms of life were simple bacteria in the oceans, which evolved the chemical

process of photosynthesis which eventually led to great changes in the atmosphere from mostly carbon dioxide to 76% nitrogen, 21% oxygen and a few parts per thousand of carbon dioxide.

- The bacteria, and later along with the plants, trees, insects and all other organisms, are the regulators of Earth as a system. **They are the boss, not humans!!**
- Only humans have the ability to mess up the system on a giant scale.
- Thus one of the major things that must happen for the survival of abundant life on Earth is for humans to understand their place in the scheme, to understand how the system works and to live in accordance.

#### c) Accelerating evolution

- With humans and their technology evolution has greatly accelerated, for better or worse.

#### d) Latecomers to evolution

- Humans are among the most recent additions to the species of Earth. But due to their unique brain and technology they have come to completely dominate Earth at the expense of other species, and even Gaia herself.

#### e) The long shadow

- Humans, along with their brilliant creations, are also causing problems concerning almost every aspect of Earth.

#### f) Crisis or challenge

- The question now is whether humans can get their act together and learn to cooperate with each other, all other species, and Gaia, or will cause such a strain that they will eventually either die out or be significantly diminished.