Life

12/7/2009
Opening Discussion

- http://www.youtube.com/watch?v=ueUOTImKp0k&
- What did we talk about last class?
- Validity of no greenhouse formula.
- Minute essays
  - Earth-sized vs. Earth-like
Let's do course evaluations. These will be done electronically on your laptops or those provided by CLT.
History of Life on Earth

- 4550 Ma: Formation of the Earth
- 4527 Ma: Formation of the Moon
- ca. 4000 Ma: End of the Late Heavy Bombardment; first life
- ca. 3500 Ma: Photosynthesis starts
- ca. 2300 Ma: Atmosphere becomes oxygen-rich; first Snowball Earth
- 251 Ma: Mesozoic
- 541 Ma: Cambrian explosion
- 588 Ma: Hadean
- 1 Ga: Proterozoic
- 2 Ga: Paleozoic
- 2.5 Ga: Archean
- 3 Ga: Archean
- 2.5 Ga
- 4 Ga
- 3.8 Ga
- 4.6 Ga
- 65 Ma
- 230 - 65 Ma: Dinosaurs
- ca. 380 Ma: First vertebrate land animals
- ca. 530 Ma: Cambrian explosion
- 750 - 635 Ma: Two Snowball Earths

Legend:
- Humans
- Mammals
- Land plants
- Animals
- Multicellular life
- Eukaryotes
- Prokaryotes
Evidence of Single Progenitor

- DNA bases, amino acids, chirality
Requirements for Life

Life could come in many forms, but we will start with the type we are familiar with and what it requires.

- Nutrients
- Energy
- Liquid water

The first two are easy for any Earth-like planet. The last one appears to be the biggest constraint.
Habitable Zones

The Sun’s Habitable Zone Over Time

- Habitable zone
  - conservative estimate
  - optimistic estimate

- Mars orbit
- Earth orbit 1.0
- Venus orbit

continuously habitable zone
(conservative estimate)

continuously habitable zone
(optimistic estimate)

age of Sun (billions of years)

0 2 4 6 8 10

distance from Sun (AU)

0 2 3
Rare Earth

- There are reasons to believe that the ability to evolve complex life is fairly rare in planets.
  - Right part of galaxy?
  - Impact rates (Jupiter)
  - Climate stability
Detecting Life

- Simple Life
  - Could be detectable through spectroscopy if there are gases that don't have geological sources.

- Intelligent Life
  - SETI looks for their signals
  - Where are they? (Fermi paradox)
Minute Essay

● Have any questions?
● I'll send out information on the timing of review sessions through e-mail.