

# AST 248

# The Search for Life in the Universe

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# Course Components

- Office Hours: 2:30 – 3:30 Tu, W, Th, ESS 449
- Course URL <http://www.astro.sunysb.edu/lattimer/AST248>
- Required text: "Life in the Universe" by Bennett, Shostak and Jakosky.
- Various supplemental, non-required, texts: assists with homeworks and term papers
  
- Exams: Three major exams, each counting 20%:  
6 October, 10 November, 17 December (5:15 PM)
- Homeworks: Count 20%, 1 per week (except exams). Will drop lowest 2 grades. Late penalty applies.
- Term Report: Counts 20%. Due October 15. Late penalty applies. Must select topic based on your ID number (see syllabus). Extra credit term report can be submitted by Nov 19. Must select a different topic.
  
- Prerequisite: One category DEC E course. This course assumes and uses algebra, trigonometry and scientific notation.
- Be forewarned about the consequences of plagiarism

# Overview of Search for Intelligent Life

1. Historical Introduction
2. Astronomical Setting:  
Distances, Masses and Energies
3. Light, Stars and Planets
4. The Universe, Cosmology and the Anthropic Principle
5. Geology and the Earth
6. Life:  
its Nature, Origin, Evolution, Metabolism, and Heredity
7. Extreme and Other Forms of Life
8. Searching for Life in the Solar System:  
the Moon, Venus, Mars, the Jovian Satellites, and Titan
9. Searching for Life in the Galaxy:  
Exoplanets and Habitable Zones
10. SETI and Consequences of Contact
11. Space Travel, the Fermi Paradox, and UFOs

# Ancient Thinking

Belief in ETI was widespread in ancient Mediterranean world –  
Pythagoras (570–500 BC), Democritus (460–370 BC), Epicurus (341-270 BC).  
Atomist theory.

In contrast, Aristotle (384–322 BC) denied multiple worlds existed, to impose order on universe.

Two ancient schools of thought about life in the universe (but these persist today):

1. Plutarch: premise of **design**—*The Face that is in the Orb of the Moon*

- The Earth is not privileged
- Heavenly bodies are not “naturally” positioned; hence there is intelligent design
- Moon is sufficiently like Earth to support life
- If Moon lifeless, it would exist to no purpose – inconsistent with intelligent design

2. Lucretius: premise of **plurality**

- Accepts 1 & 3 above.
- Believes in Atomist theory.
- No design, but innumerable worlds imply a **plurality** of intelligences.

# Less Ancient Thinking

1. Western thought through middle ages dominated by Aristotle's rigid philosophy.
  - St. Augustine believed in the theological uniqueness of life on Earth.
  - St. Thomas Aquinas wrote that God could have created many, but chose to create only one, inhabited planet.
  - Until Copernicus, the Church refused to accept these ideas.
  - After Copernicus, theology was Plutarch-like.
  - After Darwin, Lucretian-like philosophy accepted.
2. Criticism in 19th century:
  - Whewell (1854): Astronomical, geological evidence that number of planetary systems was small; "imperfect design if unredeemable souls existed on other planets".—*The Plurality of Worlds*
  - Refutation of theory of spontaneous generation (Redi, Pasteur)
  - Objections to Kant-Laplace nebular hypothesis of solar system origin raised by Jeans, who favored the catastrophic tidal theory of Chamberlin: a stellar close encounter.
3. Objections overturned in 20th century:
  - Miller-Urey experiment
  - Astronomical observations favored non-unique nature of the Earth, solar system, and the Galaxy.

# Modern Thought – 20th Century

1. Astronomical observations and Miller-Urey experiment reinforced **plurality**
  - SETI begun (Cocconi and Morrison 1960), Project Ozma (Drake 1960)
2. Not so fast!
  - Exploration of solar system reveals planets to be uninhabitable and deadly
  - SETI revolt (Hart, Tipler 1975)
  - The Fermi Paradox
  - Evolutionary biologists infer the highly random nature of evolution and debate evolutionary convergence and gradualism vs. catastrophism
  - Realization of astronomical influences on origin of and evolution of life (catastrophic impacts, supernovae, gamma ray bursts)
3. But other worlds and other life may be more common than we thought:
  - IRAS detects dust debris around young star Vega: proto-planetary disc (1983)
  - 1st brown dwarf (van Biesbrock 8) discovered, speckle interferometry (1988)
  - Advances in astrometry lead to first discoveries of extra-solar planets (1995) by Mayor and Queloz. Rapidly followed by many more, many by Marcy and Butler: 373 to date.
  - Exploration of Earth reveals tenacity of life (hydrothermal vents 1977, extremophiles 70's and 80's, deep subsurface bacteria 80's and 90's, nanobacteria 1996)
  - Martian meteorite may provide evidence of extraterrestrial life (1996)

# Some Quotes and Comments

- 400 BC** Metrodorus of Chios (Greece) “It is unnatural in a large field to have only one shaft of wheat and in the infinite Universe only one living world.”—*On Nature*
- 50 BC** Lucretius (Rome) “Nothing in the Universe is unique and alone, and therefore in other regions there must be other earths inhabited by different tribes of men and breeds of beasts.”—*De Rerum Natura*
- 1600** Giordano Bruno (Italy) “. . . an infinite number of suns with planets with life around them.” He espoused the heliocentric theory of Copernicus, for which he was burned at the stake.
- 1690** Christiaan Huygens (Netherlands) “. . . barren planets, deprived of living creatures which speak most highly of their Divine Architect are unreasonable, wasteful and uncharacteristic of God, who has a purpose for everything.” —*Cosmo theoros A consummate politician!*
- 1830** Carl Gauss (Germany) proposed building a colossal forest in the shape of a right triangle in Siberia in order to signal extraterrestrial civilizations of our existence.
- 1835** Richard Locke (USA) wrote a series of fake articles for the *New York Sun* that said British astronomer John Herschell had observed ape-like inhabitants on the Moon. About half of New York City believed him, and a large number of people continued to accept the hoax even after he confessed to writing phony stories.

- 1877** Schiaparelli (Italy) reported seeing *canali* on Mars. Although in Italian this means *channels*, it was incorrectly translated as *canals* in the popular press.
- 1880's** Percival Lowell (USA) took the press' mistranslation of *canali* and convinced himself of the existence of intelligent life on Mars.
- 1892** Flammarion (France) wrote that in the distant future, after the invention of completely new technology, civilizations might communicate across space. He didn't know that radio had just been invented!
- 1901** Tesla (USA) detected strange, rhythmic, signals on his antenna at Colorado Springs. It has never been determined exactly what he found.
- 1902** Lord Kelvin (England) proposed that Tesla was observing radio signals from Mars to New York, the "most marvelously lighted city in the world" and the only city that could be visible to Martians.
- 1920's** Marconi (Italy), after also recording strange signals, sent the first radio signals into space, in the direction of Mars, to contact extraterrestrial life there. The signals were sent from Nova Scotia.
- 1938** Orson Welles (USA) Martian hysteria reached a peak when he broadcast a version of the classic sci-fi novel of H.G. Wells, "War of the Worlds", to a New Jersey/New York audience. Thousands of people panicked upon hearing of the alien invasion.