

Tier III Course Syllabus (T322-415C, Winter 2008)

Title: *The Physics of Extraterrestrial Life*

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Class meetings: MTThF, 10:10-11:00 AM, Morton 318

Course Description

Does life exist elsewhere in the universe? This question has fascinated people for centuries. What requirements are necessary for life, as we currently know it, to exist? This question could be answered from a variety of viewpoints (philosophical, religious, scientific, *etc.*). The first half of our course will focus on the necessary *physical* conditions for life, such as how planets are formed, the requirements for life on Earth to exist, the problems of radiation, etc. All of these are threats to the chemical building blocks of life.

A second aspect of this class will be to sharpen your skills of critical thinking by evaluating possible evidence of extraterrestrial (ET) life. There are many sources claiming evidence for ET life. Some of these claims could be legitimate, whereas other claims are clearly false. How does a rational person decide which ones are possibly true and warrant further investigation? The ability to verify sources and validate information is a skill that transcends the classroom and applies to all careers. This is particularly true for references from the internet, which has become an important, but sometimes unreliable, source of information. This part of the Tier III course depends heavily on critical thinking skills. To this end, the scientific knowledge discussed in the first part of the course will prove useful.

Required Textbooks:

Sharing the Universe, by Seth Shostak, Berkeley Hills, 1998.

Beginnings: The story of origins, by Isaac Asimov, Berkeley Publishers.

The Physics of Star Trek, by Lawrence Krauss, Basic Books, 1995.

Why People Believe Weird Things, by Michael Shermer, W.H. Freeman and Co., 1997.

Course Requirements

Participation: Attendance is required. Your participation in class discussions is necessary to achieving the goals of this course. Thoughtful questions and comments will help your grade. Two unexcused absences are allowed, but each additional unexcused absence will deduct 5% from your final grade.

Reading Summaries: You are required to read the assignments as indicated for each class and write a short (minimum 1 paragraph) summary of your individual response to the readings. These are due by email at 5:00 PM each Sunday and Wednesday, and should be less than one double-spaced typewritten page of standard 8.5 by 11 inch paper. Grading is based on content (it should be clear that you did the reading), insightful questions, and synthesis (connecting to the “big picture”).

Exams: A midterm and final exam will be given. The midterm will focus on the scientific knowledge about the origins of life on Earth, and will consist of multiple choice, matching, and short answer questions. The final exam will focus on the broader question of whether life elsewhere exists, and will consist of essay questions. The grading of the essay will be based on your ability to communicate a clear line of reasoning, drawing on factual knowledge for substance.

Term Paper: A “mock” scientific proposal for research is due in week 7. Guidelines are given on the attached handout. The topic should be some area of research related to ET life, to further explore an open question suitable to your interests. The topic must be approved by your instructor. The grading will be done on feasibility (based on referenced scientific studies), chances for success (based on known technology), and importance (based on the class discussions and peer review) compared with the amount of your funding request.

Peer Review: You will be responsible for the anonymous review of the term papers from two fellow students. You will be given review guidelines and are expected to read and comment on the quality of the proposals you are reviewing, and turn these in to the instructor. You will be graded on your critique.

Group Project: A creative project as either a magazine article or short video depicting a fictional reenactment of a UFO sighting. Details for this project are given at the end of syllabus.

Activity	Percentage
Participation	10%
Readings	10%
Midterm Exam	20%
Final Exam	20%
Term Paper	20%
Peer review	10%
Video Project	10%

Class Schedule

Week 1: Was there once life on Mars?

Days M-T. Reading: None.

Introduction: course syllabus, ET life questionnaire

Lecture: What is the scientific method?

Discussion: How should we search for ET life? Drake's idea.

Reference: <http://www.jpl.nasa.gov>

Days Th-F. Reading: Shostak, pages 1-39.

Lecture: Aliens are everywhere.

Lecture: The Mars meteorite (1996 NASA News Release).

Discussion: What are the requirements for life (as we know it)?

Reference: <http://astrobiology.arc.nasa.gov/>

Week 2: How long ago did the Earth form?

Days M-T. Reading: Asimov, chapter 20.

Lecture: Comparison of the atmosphere on Earth and Mars.

Lecture: The Goldilocks Dilemma.

Discussion: What are the requirements for life (as we know it)?

Reference: <http://astrobiology.arc.nasa.gov/>

Days Th-F. Reading: Asimov, chapters 22 and 23.

Lecture: The origin of the moon.

Lecture: The formation of the solar system.

Discussion: Are there solar systems around other stars?

Reference: *Origin of the Solar System*, Jastrow & Cameron.

Week 3: What are the origins of the universe?

Tuesday Reading: Shostak, pages 41-63.

Lecture: The Doppler shift and absorption lines.

video: *The Hunt for Alien Worlds*, by NOVA.

Discussion: What (and how) do we know about other stars?

Reference: <http://planetary.org>

Days Th-F. Reading: Asimov chapter 24.
Lecture: Introduction to the Big Bang.
Video: *Cosmic Voyage*, from Omnimax theatres.
Discussion: How soon could life form? The Drake Equation.
Reference: *The First Three Minutes* by Steven Weinburg.

Week 4: How old is the earliest life on earth?

Days M-T. **TERM PAPER TITLES DUE TUESDAY**
Reading: Asimov, chapters 13 and 14.
Lecture: The Earth's core and plate tectonics.
Guest Lecture: Methods of geologic age determination.
Discussion: How well can we determine the age of rocks?

Days Th-F. Reading: Asimov, chapters 15 and 16.
Lecture: Fossil records in the Cambrian and Pre-Cambrian eras.
Lecture: Stromatolites and the earliest bacterial life.
Discussion: Are we among the first life forms in the galaxy?
Reference: NATIONAL GEOGRAPHIC, March 1998, p. 58-81.

Week 5: How did life form from a batch of chemicals?

Days M-T. **FORM GROUPS FOR PROJECT**
Reading: Asimov, chapters 17-19.
Lecture: Early Earth and the prebiotic 'soup'.
Video: *The Origin of Life*, by BBC.
Discussion: Can we produce life in the laboratory?
Reference: *Origins: A skeptics guide to the creation of life on Earth*, by Robert Shapiro.

Days Th-F. Reading: Asimov, chapter 21.
Lecture: Did all life come from a common ancestral cell?
Lecture: The RNA world.
Discussion: Which came first: RNA or protein?
Reference: *Vital Dust*, by C. De Duve.

Week 6: Radiation: energy source or terminator?

Days M-T. Reading: handout from *Life as we do not know it*.
Lecture: No protection from UV light.
Lecture: Energy sources for proto-life.
Discussion: Review for exam.

Days Th-F. Reading: None.
MIDTERM EXAM (1-hour).
Guest Lecture: How to make a video.
Discussion: Group Projects.

Week 7: If life got started, would it survive?

Days M-T. Reading: handout from Preston, pages 65-100.
Lecture: Meteorite craters on the Earth.
Lecture: The death of the dinosaurs.
Discussion: What would happen if an asteroid struck Earth tomorrow?
Reference: *Meteorites and their Parent Planets* by H. McSween

Days Th-F. **TERM PAPER DUE THURSDAY.**
Reading: handout from Preston, pages 100-132.
Lecture: Asteroid hunting and science funding.
Video: *The Doomsday Asteroid*, by NOVA.
Discussion: The fate of comet Shoemaker-Levy.
Reference: <http://www.jpl.nasa.gov/sl9>

Week 8: Space travel: could Star Trek really happen?

Days M-T. Reading: Krauss, section 1 (pp. 1-65).
Lecture: The light-speed barrier.
Lecture: The practicality of sub-light star travel.
Discussion: What is the radiation dose during space travel?

Days Th-F. **PEER REVIEWS DUE FRIDAY.**
Reading: Krauss, section 3 (pp.111-160).
Lecture: 'Warp' drive: in principle possible?
Lecture: What are the limits due to physics principles?
Discussion: The appeal of faster-than-light space travel.
Reference: *The Emperor's New Clothes* by Kip Thorne.

Week 9: The Search for Extraterrestrial Intelligence

Days M-T. Reading: Shermer, Chapter 1 (pp. 1-23).

Lecture: The SETI program.

Video: *UFO's, Are We Alone?*, from NOVA.

Discussion: What would ET life look like?

Reference: <http://seti.planetary.org/>

Days Th-F. Reading: Shermer, Chapters 2-3 (pp. 24-55).

Lecture: Pseudoscience and cults.

Guest Lecture: The truth behind the Heaven's Gate cult.

Discussion: The Roswell incident: a government coverup?

Reference: <http://www.coverups.com/roswell>

Week 10: Student Presentations

Days M-T. **Group Project Presentations.**

Reading: Shermer, chapter 4 (pp. 65-72).

Discussion: The media and "proof" of ET life.

Days Th-F. Reading: Shermer, chapters 5-6 (pp. 73-98).

Video: *Kidnapped by UFO's*, from NOVA.

Discussion: Does ET life exist?

Final Exam: Monday, November 20, 8:00-10:00 AM

Group Project and Term Paper

Group Project: A creative exercise, done in groups of 4-7, will be to make either a short (few minute) video or a series of still photographs of a fictional UFO sighting. An interview, either videotaped or written, with the fictional person who “eye-witnessed” the UFO contact. The point of this project is to learn, by real experience, the ease or difficulty to produce false evidence of UFO sightings. The fictional videos will be graded in part by the class (and in part by the professor) according to believability, consistency, and dramatic impact. A list of “credits”, showing who did what part of the project (director, writer, actor, photographer, etc.) should be included. The ‘director’ will update the professor about the progress of the group project.

Term Paper: The term paper will be a written proposal, following guidelines similar to those used by the National Science Foundation, for research into some particular area relating to ET life. While the proposals are not expected to adhere to the rigorous standards expected for successful national funding, the class will set its own standards by doing an anonymous “peer review” of the proposals. These peer reviews will be graded by the instructor based on use of critical reasoning. The purpose of this paper is to show first-hand the scientific method, which includes peer review, that is used for basic research.

Your term paper topic must be approved by the instructor. A list of suggested topics will be handed out in class. You are encouraged to choose your own topic that is somehow related to your academic major. In this way, you can use some of the expertise you have developed in your own field of study for the term paper. A title and outline of the paper are to be handed in to the instructor by the 4th week of class.

Format for the term paper follows. The first three pages will follow a set format, similar to the forms used in a real research proposal: 1) a title page, including your name, your academic major, the date and the amount of funding requested; 2) an executive summary (not more than one page) describing the research and why this research is important; 3) your resume or a short description of the background you have for this research (this should not be fictional). The main body of the text will be limited to 10 pages or less, double spaced, including all figures (if any). The following page should give a breakdown of the budget (in tabular form) of the proposed research and a short justification of why these are reasonable expenses (the budget is an *estimate* and reflects your best guess for the costs). **Three copies** of the term paper are to be handed in by week 7.

Some guidelines to consider when writing your term paper: 1) What is a reasonable budget? This will depend on the subject, as proposals for humanities are typically less costly than those in the sciences. A typical proposal should include salaries, travel expenses and any equipment costs. A budget over \$50,000 needs special justification, and might be a joint proposal between you and a professor (or some other collaborative effort). In your proposal, it is important to show what will happen with the results (e.g. will this be published in a reputable journal, or made into a documentary video, etc.)

Possible Term Paper Projects

Scientific Topics:

1. Biological study of possible life on Mars
2. Astronomical searches for new asteroids
3. Geological evidence of the earliest rocks on Earth
4. Biological origins of RNA on the early Earth
5. Search for meteorite impact craters on Earth and Mars
6. Physical radiation hazards for long-term space travel
7. Psychological evaluation of individuals claiming UFO contact

Humanities Topics:

1. Historical study of images of alien life forms
2. Political study of the government's response to the Roswell incident
3. Perceptions of technology in science fiction and literature (*e.g.*, "1984" by Orwell, or "2001" by Clark, *etc.*)
4. Study of ET invasion films and their effect on our culture (*e.g.*, The Blob, Alien, Star Trek, War of the Worlds, *etc.*)
5. Journalism's approach to reporting on UFO sightings.
6. Archaeological sites suggesting evidence for human-ET contact.

Business Topics:

1. The economic impact of ET movies, toys, and other paraphernalia
2. Marketing opportunities to exploit the ET craze
3. The cost to the taxpayer of government studies of UFO's.
4. How businesses can profit from NASA's funding priorities.
5. The economic impact of ET movies, toys, and other paraphernalia

Other Topics:

1. Your own creative idea (approved by the instructor).