Astronomy 309L (46765)--Scalo
The Search for Extraterrestrial Intelligence

Syllabus

Classroom and time: Welch 3.502, MWF 2

Professor: John Scalo

Office: R.L. Moore 17.220

Phone: 478-2748 (home; best place to call me); office number is 471-6446.

email: parrot@astro.as.utexas.edu

Office hours: M4:30-5:30, W4:45-6:00. Meetings at other times can be easily arranged. However I urge you to feel free to call me at my home or office, or to talk to me after class (in the foyer just outside the classroom--I have free time after most of our classes except on Wednesdays); for short questions there is usually no need for you to walk all the way to my office, and I welcome phone calls at home.

Teaching Assistant: Nairn Baliber

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Office hours: T 1-3; Th 3-5 (tentative)

Class Website: link to it through http://www.as.utexas.edu/astronomy/education/courses.html

The course website will contain the syllabus, an outline of most class lectures, and illustrations you can download; extra reading in the form of articles that will be assigned (you can read them online or print them); a way for you to easily check your exam scores; and a simple way for me to distribute handouts or make slight revisions to the reading assignments. I will explain downloading of articles to you in class. I urge you to check the website often.

Reading:

Required book: Bennett, Shostak, & Jakosky (BSJ), Life in the Universe (1st ed., 2003)

(This book is expensive, but was used in the Fall, and last Spring, so you should be able to locate a used copy; even if not, you will be able to get the "rebate" by selling your book at the end of the semester, unless you form a deep emotional attachment to it, as I'm sure you will.)

This is a rapidly growing interdisciplinary field, so the textbook will have to be supplemented by the lectures and by outside readings. These additional readings will be made available through the class web site and on reserve at one or more of the UT libraries.

A list of the reading assignments for each topic covered in the course is given below. More detailed guides to the reading assignments will be handed out separately.

Grading:

Exams: 100% of your grade will be based on five exams, All exams will be weighted equally *except* that your lowest exam score will only receive a weight of 1/2 compared to the others. So you have to take all the exams, but if you have an off day (or week, etc.) it won't hurt your final grade too much. The topics and dates of the exams (tentative—any changes will be announced heavily in class and at the class website) are listed below. There will be no comprehensive final. The exams will consist almost entirely of multiplevbchoice questions, depending on class size. I will try to prepare you for the nature of the exam questions by occasionally giving sample questions during lectures, by trying to point out the types of information that I expect you to understand or remember, and giving examples on review sheets.

In case of medical or other non-academic emergencies or situations, contact me as early as possible—it will usually be possible for you to take an exam a day or so early or late in these cases (but not for academic reasons).

We will try to get exam grades available to you through the UT e-Gradebook system (at https://utdirect.utexas.edu/diia/egb/) within one or two days of the time of the exam. Usually you should be able to get your exam grades on the same day (or evening) as you take the exam.

Final grades are assigned on the basis of A=87-100, B=78-86.9, C=67-77.9, D=55-66.9, F<55.

Homework: The homework in this class will be ungraded except in the sense that references to it will appear on each exam in the form of an exam question. Usually once per week I will send out class email containing one or more questions relating to the topic you are reading about and I am lecturing about. You should try to answer these (for yourself, not to me) within a day or two of receipt of the email. Most of these questions will be basic and fairly easy, and serve the purpose of having you keep up with the reading and lectures (lagging on these is the most common cause of grade decline in this class); many will involve searching on the www concerning developments too recent to be covered in your text (e.g. the recent Mars and Titan missions). These questions will be much more difficult to answer if you wait until just before the exam—it will take you longer to dig up the answers during a time when you should be just studying for the exam. I will always insert exam questions that directly test whether you know the answers to these questions—that is how you will be "graded" on these homework questions.

Just under the cutoff?

If at the end of the semester you are just under the cutoff for a grade (by, say, one, or two, or 0.3, percentage points), whether you are just under a D, say, or an A, do *not* call Prof. Scalo asking him to lower the cutoff--this is unfair to all concerned. Cut-offs will *not* be lowered to accommodate your individual score. Scores at the end of the semester are *not* rounded up, so, for example, a 77.7 will get you a C.

Special requests

If you have *any* special request of *any* sort (excluding those not allowed, like lowering the grade cutoff), please put the request in writing, preferably by email, or call me on the phone. Please state clearly and explicitly your request and why it is reasonable. Include a phone number so that I can contact you about your request.

Obviously (I hope) this procedure does not apply to minor requests such as "Could you write a little larger on the board?" etc. Any suggestions for improvement of the class as we proceed will be greatly appreciated, either in person, by phone, or by email.

Attendance

Although I will not take attendance records because of the class size, you should keep in mind that the exams are based heavily on the lecture material (as well as the textbook and other readings), and that the "notes" that I will make available to you are only outlines or abstracts of my lectures. The biggest single danger in this course is to fall far enough behind, either through lack of reading or spotty attendance, that you cannot really understand the material being covered. I therefore urge you to attend all classes.

Dropping the course (see http://www.utexas.edu/student/registrar/01-02long.html#Spring and *General Information*, ch.4, for details of required approvals).

The College of Natural Sciences adheres strictly to the published deadlines of the University.

… **4th class day**: Dropping courses electronically: During the first four class days, students may add and drop courses using TEX, the Telephone Enrollment eXchange or the world wide web with ROSE.

… **12th class day**: Last day to drop a class with possible refund: During days five through twelve (Feb.2, 2005) students may drop courses by phone, but must go to the department offering the course to seek permission to add a course. Be advised that some departments do not allow adds/drops after the fourth class day. For those departments that do allow adds/drops, the add-transactions before the twelfth class day will be processed by terminal in the respective department.

… **20th class day**: Deadline for dropping a course without possible academic penalty: The deadline for dropping a course without possible academic penalty is the end of the fourth class week (Feb. 14, 2005 for the spring semester.) During this period a Q is automatically assigned but no refund is provided. If at all possible a substantial course grade should be assigned by this deadline to assist students in making an informed decision about dropping a course.

… **40th class day**: Last day to drop a course, for urget and nonacademic reasons, with Dean's approval: After the end of the fourth week of class, and until the deadline for dropping courses (March 28, 2005, for the Spring semester), a student wishing to drop a course will get the forms from the Dean's Office (WCH 1.106) and ask the instructor to complete the drop form that assigns a Q or an F. The symbol Q indicates an average of C or better at the time of the drop, or that no grade has yet been assigned, or that due to the student's performance and the nature of the course, no academic penalty is in order, or that for documented non-academic reasons, no academic penalty is in order.

… **Non-academic Q-drop**: After the last day for academic Q-drop, students with substantiated non-academic reasons (as determined by the Dean's Office) may be allowed to drop a course. Faculty will be asked to provide information on student performance up to the time of the non-academic Q-drop request but are not responsible for making the decision about assigning a grade of Q. Students who experience significant non-academic problems such as extended health-related problems or family emergencies are urged to contact the Dean's Office.

The College of Natural Sciences is not obliged to honor the "one free drop" policy of some other colleges (e.g. Liberal Arts), so do not ask me for a Q drop after the deadline (March 25) for academic reasons (i.e. because your grade is low), no matter what a counselor in your college may have told you.

Incompletes

An incomplete (X) will only be considered for students who cannot complete the required course work for reasons other than lack of diligence (illness or other imperative nonacademic reasons), but only if the student has a passing grade on the work completed.

Cheating

Academic dishonesty will result in failure of the course and a report to the Dean of Students, who will decide on further action. Because of the large size of this class and the temptations involved, it will be important to keep your eyes from wandering and to guard your own exam. Students near the rear of class should try to sit one seat apart. Also, bring your UT ID card with you to exams and be prepared to show this card if asked.

Student observing opportunities (call 471-5007 or see http://outreach.as.utexas.edu/public/viewing.html for Monday updates; information below is tentative)

Students interested in observing the night sky through small telescopes have several opportunities. **1**. The Painter Hall Observatory has UT Student/Staff Night on Fridays and Public Night is on Saturdays. These sessions are free and open to all ages; no reservations are required. **2**. The Astronomy Department sponsors weekly "Star Parties" on the 18th floor observing deck of R. L. Moore Hall on Wednesdays. This is free and open to the public. Call phone number or see url listed above for current times.

Course Description (please read carefully)

This course is generally concerned with interdisciplinary issues surrounding the possibilities and implications of extraterrestrial life and intelligence. These issues include whether habitable planets around other stars are commonplace, how likely or unlikely life is elsewhere (based on theories and evidence about the origin of life on earth), whether we should expect life to commonly evolve toward creatures possessing "intelligence," language, technology, etc. (and whether we actually understand these terms), speculations concerning the nature and lifetimes of alien civilizations, strategies for communication with extraterrestrials, interstellar travel, and the question of whether we have been visited by extraterrestrials. *Please note from the outset that the course is highly interdisciplinary by nature, and that only a fraction of the material (maybe a quarter to a third) is directly astronomical.*

At one level, the subject of extraterrestrial life can be discussed in terms having to do with the physical and biological sciences. For example, the question of which stars are most likely to have planets bearing life will involve discussions of the origin of planetary systems, current searches for planets around other stars, and theories and evidence related to the origin of life on earth. Questions concerning how we should "listen" for alien signals involve consideration of light propagation, spectral lines [just barely: don't let this frighten you], and sources of interference. Whether or not you think creatures even remotely like us will develop elsewhere depends on your view of terrestrial biological evolution, so we will discuss current points of view on that subject. As we proceed into the course, the subject matter will gradually shift away from the physical sciences as we inquire into the nature of biological evolution, "intelligence", language, culture, cognition, and how they might differ (or not exist, or be replaced by alternative concepts) in extraterrestrial life forms. The possibility of machine intelligence and its future, and recent theories about the nature of consciousness, may also be reviewed critically if time permits.

However most of the course will be devoted to the areas of the study of extraterrestrial planets and theories and experiments concerning the origin and evolution of life here and elsewhere. That is most of the subject of "astrobiology" or "exobiology." This subject has experienced a huge resurgence of scientific interest in the past several years due to several factors. These factors include the discovery of a large number of planets around other stars, the realization that we may be able to detect Earth-like planets in the near-future, the possible evidence for biological traces in the "Martian meteorites," and the advent of space missions that will directly explore possible life abodes in our solar system (e.g. a Europa probe). Astrobiology has finally become a legitimate field of science, with its own institutes, funding programs, and even universities that offer advanced degrees in the subject. Other aspects of the problem, like "listening" for signals or signs of extraterrestrial technological civilizations ("SETI" programs) and even potential designs for star travel vehicles are also under study, so we will devote a significant fraction of time to these topics.

The material will almost entirely be non-mathematical, concentrating on a number of key ideas that can be understood without math. There is also a fairly large vocabulary of terminology with which you should become comfortable—this should help a lot in studying for and taking exams.

AST309L: SCHEDULE OF TOPICS, READINGS, AND EXAM DATES

I will list topics according to the organization of the textbook (e.g. 5.2 means section 5.2 in Bennet et al.'s book). Although I like the clarity and production of our textbook, I decided to alter the order in which we will read its various sections. That makes it very important for you to make a copy of this reading list and keep it handy.

I will divide the course into five sections, with an exam after each section. The exam dates are only a little tentative, and time constraints may cause one or more of them to shift by one class day. I will give you plenty of advance warning if such a change is coming, and will try to avoid it.

I. Habitable planets

11.1 Overview in terms of the "Drake equation" (**11.1**)

Ch. 1 Review of astronomy, origin of elements, disk and planet formation (covered in much more detail in class and outside readings).

Ch. 2 You are only required to read 41-48.

Ch. 9. (Evolution and) Habitability

9.1 Habitable zone, **9.2** Venus as example, **9.3** Surface habitability, **9.4** Sun's habitable zone, **9.5** Future of life on Earth

Ch. 10--The Search for Habitable Worlds

10.1 Brief intro, **10.2** Stellar habitability, **10.3** Methods and discoveries of extrasolar planets (covered in much detail in class + outside reading).

10.4 Signatures of habitable planets (+ outside readings)

10.5 Earth-like planets—rare or common?

[Depending on time available, we may have to postpone 10.4 and 10.5 to the 2nd exam material.]

Outside reading: Two chapters from Koerner & LeVay's book (one on disks, the other on planet detection). These will be put at the web site so you can download them as pdf files.

.....Our first exam will occur here (Friday, Feb. 11) .....

II. Origin of life by chemical evolution

Ch. 3. The nature of life on earth—characteristics of life, cells, metabolism, genomes, extremophiles. Topics I will cover in more depth in class are:

Elementary background on molecular bonds, chemical reactions and cell biology.

Why carbon? Why water? Alternative biochemistries.

Molecular basis of life—prebiotic organic molecules; amino acids, nucleotides, proteins, nucleic acids.

Ch. 5. Origin and Evolution of Life on Earth—We will only cover the "Origin" part of this chapter here, which means only subsections **5.1** and **5.2**, especially **5.2**. I will fill in more detail in class, especially concerning origin of life scenarios and problems. There will also be outside reading.

Alternate biochemistries again; strange life forms, artificial (digital) life (if time permits).

Panspermia (esp. from Mars) revisited.

Some outside reading possible.

…….Second exam here (Friday, March 4)……

III. Life in the Solar System?

Chapters 6 through 8

Ch.6 Searching for life in our solar system

Ch.7 Mars (+ additional readings on Mars missions)

Ch.8 Jovian moons (+ additional readings on Titan mission)

.....Third exam here (Wednesday, March 30).....

IV. Terrestrial biological evolution and intelligence; extraterrestrial intelligence?

Ch. 4. Geological history of the earth—ages from radiometric dating, formation of Earth and Moon, Hadean Earth, climate change.

Outside reading: Snowball earth episodes?

Evolution—class lectures on the standard view of mutation, diversity, and natural selection; more recent developments; concept and importance of evolutionary convergence. We are mostly trying to understand the most important developments in evolution, and whether they would occur elsewhere, leading to "intelligence," at least as we know it.

Back to **Ch. 5 (**sections on evolution):

5.3 Early evolution and rise of oxygen ("oxygen catastrophe")

5.4 Development of eukaryotes

Class lecture: significance of photosynthesis, meiosis, …

Outside reading on "Cambrian explosion"

5.5 Impacts and extinctions

5.6 Human evolution (discussion of human uniqueness and problems)

11.2 Intelligence—This will be supplemented with outside readings from cognitive science, cross-cultural and animal studies, artificial intelligence research. We will discuss in detail in class lectures. This is crucially important in designing strategies for signal detection (see below).

If time: speculations on postbiological evolution; artificial intelligence.

……Fourth exam here (Friday, April 22)…….

V. Modes of contact

Ch. 11 The search for extraterrestrial intelligence (SETI)—listening strategies

11.1 Drake equation (again). Emphasis on importance of lifetime of a technological civilization—how could L be large enough to allow contact?

11.3 SETI experiments (proposed encoding and signaling techniques, "magic frequencies," ongoing SETI programs)

11.4 SETI today

If time: The nature of language and its possible alternatives

Ch. 12 Interstellar Travel-- limiting factors, proposed designs. Possibility of exotic physics

Ch. 13 The Fermi Paradox-- Galactic colonization and the "Where are they?" conundrum.

Ch. 14 Contact—Implications of search and discovery

In class lecture (time permitting):

UFOs, artifacts, abduction phenomena,...

..... Fifth (last) exam here, on last class day (Friday, May 6).

There is no comprehensive final. You should be able to compute your final average score (we will give you a formula to help) and so you will know your letter grade in the course after receiving the results of the 5th exam. The only exceptions would be borderline cases.