AST 309L—Spring 2004
Review sheet for Exam #5

The material for this exam covers three areas: 1. Strategies for communication with extraterrestrial civilizations; 2. Interstellar travel, and 3. The Fermi Paradox. These correspond to chapters 11, 12, and 13 in the text. All three topics were discussed in detail in class. Notice that chapter 11 contains a little material on intelligence; although that was part of the previous exam, you should read this material, since I specifically did not ask questions about "encephalization quotient," which is discussed there. I will only ask one question about that. You should read the concluding chapter (14) of your textbook—it is only a few pages long and gives a nice overview of everything that has gone before.

There is no outside reading associated with this exam—ignore any reference to "Evans" in the notes.

Concerning the material on alien visitations (sec. 12.6): It is difficult to come up with questions for this material, and we did not have time to discuss in class, but I do want you to read it. I will only ask one, very general, question on the exam about this, something like "The authors of your textbook conclude that…." (Notes on this topic are available at the course web site but you won't be tested on them.).

Sec. 12.5 (hyperspace and wormholes) is extremely interesting, but so speculative that I am not going to include any test questions covering that section.

As a review, try to answer the following. You probably understand the material when you are able to give answers in coherent sentences that do not use a lot of jargon, and without referring to the book or notes. If you find that you cannot answer these questions in this way, you probably do not yet understand the material sufficiently.

Concerning interstellar communication:

1. What considerations are important in narrowing down the range of frequencies (wavelengths) that should be monitored by ETI searches? You should be able to explain, at a simple level, the major sources of blockage and interference, and know whether they are most important at low or high frequencies (or wavelengths). For example, why not search using UV light? Why not the largest radio wavelength? What are advantages and disadvantages of optical SETI?

2. Why would it be useful to choose a "special" frequency corresponding to some spectral line, or some range of frequencies based on "special" frequencies? What are the disadvantages of this approach?

3. How might extraterrestrials (or we) encode pictures in binary strings? What is the significance of prime numbers in the most common of these encoding strategies? Try to think of a simple example, like a picture of a letter or number.

4. Why might "leakage radiation" from the earth look like? Why is it unlikely that we could detect such leakage radiation from an extraterrestrial civilization if it is similar to ours?

5. What are alternatives to radio SETI searches and what are their advantages and disadvantages? Here I'm referring to things like optical SETI and searches for Dyson spheres.

Review questions 1, 5, 6, 7, 8 on p. 295 of your textbook are also useful.

Concerning interstellar travel and Fermi's paradox:

6. You should be able to discuss in words the various types of proposals for star travel and their limitations, advantages, and disadvantages. This is the material in secs. 12.1-12.4 (but not 12.5), expecially sec. 12.3 and 12.4.

7. In a short sentence, what is the Fermi paradox and why its simplest interpretation suggests the futility of SETI searches?

8. Explain why most proposed explanations seem incapable of accounting for the absence of extraterrestrials on earth today. (e.g. there hasn't been enough time to colonize the galaxy; maybe all the aliens are meditating or painting and are not interested in colonization; etc.)

9. Suppose that a technique was discovered for traveling at very close to the speed of light (say 0.99 c). Which of the possible explanations for the Fermi paradox would be most affected and how would this affect the possible conclusion that N is a very small number?

10. Why is it so darn difficult to attain speeds that are a significant fraction of the speed of light? Describe some of the suggested ways to circumvent these difficulties.

Review questions 2-8 on pp. 319-320 and 2-7 on p. 335 are also useful to consider.

Here are some terms that you should be familiar with. Note that these lists are meant to be guides, and do not imply that all terms on these lists will be used on the test, or that these are all the terms you should know (there are many more!). They are just here to help you organize your study for the exam. Some other terms and names that are important are contained in the questions above.

For interstellar communication:

Sources of background noise neutral hydrogen emission line the "Water Hole"
interstellar dust supernova remnant radio emission ("synchrotron" radiation)
terrestrial atmospheric interference quantum noise Dyson sphere
Project Ozma Project Phoenix Project SERENDIP Allen Telescope Array
leakage radiation optical SETI

For interstellar travel:

nuclear fission nuclear fusion matter-antimatter annihilation
relativistic effects –time dilation, change in mass.
Project Orion Project Daedalus Bussard ramjet solar sails
laser sails ion engine Von Neumann probe
You ***don't*** need to know: Project Cyclops, Pioneer, or Voyager.

For the Fermi paradox:

There isn't much terminology to remember (e.g. Von Neumann machines, coral model,…). Concentrate on understanding the arguments why most of the possible solutions are not plausible, and that the simplest explanation is not very optimistic for SETI searches. Make sure you understand the distinction between the Fermi paradox and its possible interpretations, most of which are explained in your textbook.

Here are some sample multiple choice questions. Remember, the main point of these is to see if you can answer them *without* referring to the textbook or notes. So first try them without referring to anything, to get an idea of whether you could already answer them on the exam.

1. When enthusiasts for communication with aliens speak of the "water hole" they mean
   a. a range of radio frequencies between two important emission lines of water

b. a range of radio frequencies where emission lines of water are concentrated
c. a range of radio frequencies between a spectral line of OH (hydroxyl) and one of atomic hydrogen (H I).
d. a particular radio frequency marked by a prominent emission line of water

2. Which effect most limits our ability to detect ETI signals at very small frequencies (large wavelengths)?
a. receiver (or quantum) noise
b. radiation from supernova remnants throughout our galaxy ("synchrotron radiation")
c. absorption by interstellar dust grains
d. the cosmic microwave background radiation

3. A big advantage of the Allen Telescope Array is
a. It is more sensitive than any previous SETI program.
b. It does not have to be used for other types of astronomical observations.
c. Its location makes terrestrial interference less of a problem.
d. Its radio dishes are effectively larger than any previous SETI search, even though they are individually small.

4. What is the fundamental problem with nuclear fusion as a power source for interstellar travel?
a. It is too inefficient.
b. It requires too large a mass ratio.
d. The material needed for the reaction is rare.
d. We don't know how to contain it in a controlled way.
e. Leakage radiation would require excessive shielding.

5. The major difficulty with the Bussard ramjet could be overcome if
a. the density of hydrogen gas along the travel route was much larger than average.
b. some way could be found to accelerate the ship during the initial stage.
c. the technology to build magnetic shielding were available.
d. a technique could be found for containing matter and antimatter.

6. A major problem with laser sail proposals for star travel is:
a. The shielding of the sails from interstellar particles requires excessive mass for the sail..
b. The ship could not slow down unless there was a laser already in place at the destination.
c. Even in principal (e.g. with a perfect, infinitely powerful laser), this method could not attain a significant fraction of the speed of light because the light intensity decreases with distance (inverse square law).
d. The fuel that the laser would have to ignite is far too massive.

7. Suppose that it was discovered that it is practical to travel at very close to the speed of light (say 0.99 times the speed of light). How would this affect the simplest interpretation of the Fermi paradox, that we are essentially alone in our Galaxy?
a. It would have no effect on this interpretation.

b. It would strengthen it because it should be easier to colonize the Galaxy.
c. It would strengthen it because it would be more difficult to use relativistic effects to collect fuel from interstellar gas.
d. It would weaken it because alien civilizations probably wouldn't have had time to colonize the galaxy.

I urge you to call me (usually 478-2748, leave clear message with your phone number if I don't answer) if you have questions during your studying, but also not to wait until the night before the exam, or we won't have much time to talk. Nairn Baliber and I will also have office hours from 3:00 to 5:00 on the day before the exam.