

Endings, Spring 2006

### Questions for study V

(be prepared to discuss Tuesday, May 2, and turn in these questions thereafter)

Ward and Brownlee, *The Life and Death of the Planet Earth*

1. (page 180) Name **two assumptions** being made here about radio waves.
2. (page 183) What's a "**pulsar**"? Why might they have been mistaken for signals from an **alien civilization**?
3. (page 187) **Von Neumann machines** (specifically, von Neumann probes) are not really explained well here. Find a better definition of what a von Neumann machine or probe does, and **please cite your reference**.
4. (page 191) The **Allan Hills Meteorite** mentioned here seems to be implicated in bringing life (microbes) to Earth. Go to an appropriate website or book (by appropriate, I mean something published or updated within the last three years) and find out what the **current status** is on whether this meteorite is thought truly to have brought microbial life to Earth. Give **one piece of evidence** of how we came to this conclusion and **cite your reference**. (Hint: the meteorite is often known by its catalog name ALH 84001).
5. (page 191) Time to introduce you to a wonderful resource on-line for our solar system: <http://www.nineplanets.org>. This site, maintained by Bill Arnett for many years, is a wonderful up-to-date compendium of all sorts of different planetary research sources. Go to the site, click on the Mars link and find **another** reason (apart from the reasons that Ward and Brownlee give) why **Mars probably does not support life** now.
6. (page 193) Ward and Brownlee claim "seventeen" extrasolar (beyond our own solar system) planets discovered "so far". Another nice web resource is for extrasolar planetary research; it is located at <http://exoplanets.org/>, maintained jointly by the University of California and the Carnegie Institute of Washington. The copyright on the Ward and Brownlee book is 2002; **how many extrasolar planets** have been found now (up to February, 2005)? Click around the various links of this site and find out the size of the **smallest extrasolar planet** discovered so far is. Also find out **the largest number of planets** in any extrasolar system so far. Note the last two points are directly related to the Drake Equation.
7. (pages 195 to 197) What property or properties define:
  - the inner edge of the solar system **habitable zone**
  - the outer edge of the solar system habitable zone
  - the inner edge of the galactic habitable zone
  - the outer edge of the galactic habitable zone
8. (page 207) Ward and Brownlee dismiss the notion of interstellar travel with the sentence "The difficulty of "practical" travel between the stars is getting there on the

timescale of a human life span." NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, has several craft on "Interstellar Missions". One of these is **Voyager 1**, the **fastest** and **furthest** human-made object, launched back in 1977. Go to <http://voyager.jpl.nasa.gov/mission/interstellar.html> and determine the **number of years** to the next stellar "close encounter" Voyager 1 will have. Does this **confirm** or **refute** Ward and Brownlee's flippant point?

9. (page 200) This is not a question. "**Terraforming**" is the term applied to human engineering of Mars to be inhabitable by humans. Even though Ward and Brownlee point out the difficult aspects of terraforming Mars, it does not stop human writers from speculating about how to do so. Recent good examples of such books are the *Red Mars/Green Mars/Blue Mars* trilogy by Kim Stanley Robinson, *Moving Mars* by Greg Bear and *Mars* by Ben Bova. Please read these *after* you finish the course readings!

Davies, *The Last Three Minutes*

10. (page 85) Many of the stars in the night sky are part of a **binary system**; two stars orbiting a common center of gravity. An example of this is the bright star Sirius, which is actually a binary system of Sirius A and B. Given what is said on this page, how many trinary (three star) systems would you expect? Explain your answer.

11. (page 88) How does **energy conservation** work with a black hole, given that it emits **Hawking radiation**? In other words, where does the black hole get the energy to make Hawking radiation?

12. (pages 94 through 96) Give two means by which a **proton might decay** into a positron.

13. (page 98) So what will the **ultimate makeup** of the universe be, if all the processes mentioned in this chapter occur? There is the chilling line: "As far as we know, no further basic physical processes would ever happen." How is the second law of thermodynamics consistent with this bleak view?

14. (page 101) Why **Jeremiah**? Wasn't he a bullfrog? No, wrong reference; to which Jeremiah is Davies referring to?

15. (page 102) Not a question. Note that in his estimate of how long humans have in this solar system, it is evident that Davies has not read Ward and Brownlee. To be fair, Davies published his book before Ward and Brownlee.

16. (page 106) Davies does seem to be more sanguine about our chances of colonizing space. Consider the quote: "A challenge like the human genome project, which may be a daunting task for a single generation of scientists, would be straightforward enough if a hundred, or a thousand, or a million generations arose to carry out the work." Now consider the ten thousand years of human civilization, that has taken us from the invention of agriculture to the invention of speculations like this book. Estimate a **reasonable number of years per generation** (you may look at your own family

genealogy), then calculate the number of generations since the invention of agriculture. Please **show your calculation**.

17. (page 108) There's this whole notion of the "**energy cost**" of **computation**. All your thought processes as well as information gathering (like seeing) are computations because your brain is moving electrical impulses from one part of the brain to another and storing it there (the definition of computation). From what source does this "energy cost" of computation arise? What do we get in return for paying this cost?

18. (pages 109 and 110) This fellow **Freeman Dyson** seems to be hung up on the whole energy consumption by civilizations thing, doesn't he? Find a reference on Freeman Dyson and find out how a "Dyson sphere" is one possible, albeit limited, solution for a civilization's energy requirements. Please **cite your reference**.

19. (pages 117 and 118) Throughout this course, we have used the terms "entropy" and "complexity" as opposites, and therefore, if complexity increases in any system, some other part of the universe must become more disordered (higher entropy) to compensate, according to the second law of thermodynamics. Davies makes a crucial distinction about forms of complexity, using as examples a bacterium and a crystal. Come up with your own example of objects or systems that illustrate these **different kinds of complexity** on the **planetary scale or above**.

20. (page 121) Another crossover! Pray tell, what is the nature of Martin Rees's "**eschatological study**"? Using whatever source you can find, look up a synopsis or summary of Rees's *Just Six Numbers*. How does this relate to his eschatological study? Please **cite the reference**.