Science 100

Questions for Discussion VIII (be prepared to discuss on Wednesday, March 2)

Instructions: Same deal as before. Due midnight on Wednesday.

Davies, The Last Three Minutes

1. (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.

2. (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?

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

4. (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?

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

6. (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.

7. (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**.

8. (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?

9. (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**.
10. (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.