

Endings, Spring 2006

Questions for study II (be prepared to discuss and turn in these questions either Tuesday, April 11 or Wednesday, April 12)

Instructions: These questions are designed to direct your reading, in preparation for the seminar on these chapters (note that these are not the seminar questions themselves). Please word-process, double-space and proofread your answers prior to submission; it is fine to e-mail me a Word document in lieu of turning them in class (of course, you should retain a copy for yourself for discussion purposes!).

Davies, *The Last Three Minutes*

1. (page ix) What is “**cosmic background heat radiation**” (sometimes called CBR)? How did this “prove” the **Big Bang** Theory?

CBR is the alleged remnant of the Big Bang, the hypothesized “beginning” of the universe. Big Bang theory holds that all energy (and therefore matter) in the universe was contained in a single point (a singularity) about 12.8 billion years ago (age estimates vary due to quasar measurement uncertainties). For some reason, this singularity expanded and has been expanding since, turning into the universe we inhabit. The temperature of the singularity, as might be imagined, was extremely high and, due to the expansion, has decreased over time; the CBR (about 3 Kelvins) is the vestige of this temperature.

2. (page xi) On the use of **scientific notation**: The distance from the earth to the sun is 149,600,000 kilometers; express this number in terms of scientific notation. The distance from one carbon atom to another in DNA is 0.000000000142 meters; express this number in terms of scientific notation. What is the **advantage** of expressing numbers in terms of scientific notation (apart from looking, well, scientific, anyway)?

1.49×10^8 km. 1.42×10^{-10} m. Clearly, scientific notation is more concise; it also allows the reader to quickly determine to what precision we have measured these numbers.

3. (pages 4 and 5) What’s the difference between a comet and an asteroid? What are their similarities?

A comet is a primarily icy body that orbits the Sun such that it occasionally comes near enough to be affected by the solar wind, which vaporizes and ionizes some of the icy material to form a coma and a tail. An asteroid is a primarily rocky body that orbits the Sun. Both can be sand grain-sized on up to hundreds of miles in diameter. Both can have orbits that intersect the Earth’s orbit. Both have numbers in the thousands (probably millions).

4. (page 6) What is the Nemesis theory? On what force does the Nemesis theory rely, in order to bring about Earth’s doom?

Nemesis is the name given to an as-yet undiscovered companion star to the Sun, attracting each other by the force of gravity. Richard Muller, a researcher at the Lawrence Berkeley Laboratory, explains (on his website www.muller.lbl.gov): "The Nemesis theory was devised to account for [the] regularity in the timing of the mass extinctions reported by Raup and Sepkoski. According to this model, a companion star orbiting the Sun perturbs the Oort comet cloud every 26 [million years] causing comet showers in the inner solar system. One or more of these comets strike the Earth causing a mass extinction. The Nemesis theory was originally published in Nature by Davis, Hut, and Muller (vol 308, pp 715-717, 1984)."

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

5. (pages 1 and 8) **Carbon dioxide** is said to be a greenhouse gas, because it lets sunlight go through the Earth's atmosphere but does not let heat back out through the atmosphere. How did the light become heat, anyway? Or was there another source for the heat? And how is it that carbon dioxide does not "let" heat escape – it's not like a molecule of carbon dioxide has hands!?

Light from the sun is transmitted through the atmosphere (a small percentage is reflected or scattered) and hits the rocks and the oceans of Earth, causing them to warm. This is the conversion to heat energy. At night, the second law of thermodynamics takes over and the comparatively warm rocks and oceans release heat back into the atmosphere to go back to space. However, carbon dioxide's molecular structure is such that the frequency at which its bonds vibrate is the same frequency as the infrared (IR) radiation that the emitted heat has. Thus the carbon dioxide molecules absorb the heat energy and keep the heat as molecular motion close to the Earth's surface.