

Endings, Spring 2006

Questions for study IX

(be prepared to discuss Thursday, June 1, and turn in these questions thereafter)

Davies, *The Last Three Minutes*

1. (page 128) The **light cone** shows up again: here, only half of the double-sided cone I drew in class is depicted. Davies calls this the “past light cone” because it shows the shaded area of events in the past that are possible to know. In the caption, he states “an apocalyptic event outside the past light cone might be sending disastrous influences (wavy line) racing toward Earth, but the observer would be blissfully unaware of this until the influences arrived.” Recalled I mentioned a *tachyon*, a theoretical **faster-than-light particle**. Suppose tachyon bullets were invented. How could you defend yourself against being shot by a tachyon bullet?

You don't worry about it; since no particle can pass through the “light speed barrier” in the light cone, it means that a faster-than-light particle (like a tachyon) cannot interact with a slower-than-light particle (such as you).

2. (page 132) The idea of a false vacuum state shows up again. What prevents you from suddenly experiencing massive (and fatal) **quantum tunneling**, leaving you suddenly embedded in the ground? However, are there inventions around today that rely on quantum tunneling? If so, name one.

Like the Heisenberg Uncertainty Principle, quantum tunneling is best done small, on the scale of an electron. The probability that all of the particles in your body would suddenly translocate one meter down, though non-zero, is ludicrously small. Some high-speed microprocessors, however, do rely on quantum tunneling as a means of computation and thus are an effective example of the usefulness of the phenomena.

3. (pages 134 and 135) To bring the course ‘round full circle, is it possible that human actions will precipitate a “scientific apocalypse”? By this I don't mean nuclear war or any such trivial thing; I mean the whole universe ends due to our actions! Briefly summarize the argument on these pages for a **human-initiated apocalypse**.

In the process of smashing together particles at high speeds (energies) in an accelerator, it may be the case that a true vacuum will be generated, when all the virtual particles that can be made out of a false vacuum are made. The true vacuum represents a lower energy state than the false vacuum, so the false vacuum around us will relax into a true vacuum state. In other words, the true vacuum will grow. This is highly disruptive to life and other everyday activities, and it is one driven by the potential energy minimizing principle of the universe and thus is hard to see how to stop once started.

4. (pages 135 to 138) Yet in the apocalypse of the previous question may lie our salvation. What is a “**baby universe**”? What do **wormholes** have to do with these “baby universes”? And how is this an **escape route** from the apocalypse? Incidentally, you can tell this book was written by a citizen of the UK; check out the Dr. Who reference on page 136.

A baby universe is a pinched-off part of this universe; the neck of the pinch-off is a black hole, which effectively blocks communication between our universe and the baby one. This means, though, that the ending of this universe will not necessarily end the baby universe. In fact, Davies' hope is that technological hurdles (as well as some physical principles) can be overcome so that those of us left in this universe might be able to escape through the black hole into the baby universe prior to the end of this universe.

5. (page 138) Paranoia abounds. If the theory about baby universes proves true, then what is suggested about the **origin** of our own universe and the **Big Bang**? "He was part of my dream, of course — but then I was part of his dream, too!" Lewis Carroll, *Through the Looking Glass*

Perhaps we are one of the baby universes!

6. (pages 142 to 145) Last question: Give **two reasons** why the **cyclic universe** of alternating Big Bangs and Big Crunches is unlikely as a plausible scientific model (apologies to those of you who really wanted this scenario to be true).

One — the lag time of starlight continuing to expand outwards and the pull inwards of gravitational contraction. This leads to the problem that there will be extra heat in the contracting universe — matter in the expanding universe that was converted to heat as the universe contracted. The heat-filled contracting universe would contract faster than the matter-filled expanding universe expanded, and thus each Bang/Crunch cycle would be longer-lived than the previous, leading to longer and longer "cycles".

Two — something has to cause the Big Crunch to turn into the next Big Bang, a massively repulsive force, the likes of which we have absolutely no idea!