

MIT OpenCourseWare  
<http://ocw.mit.edu>

The Big Questions  
Spring 2008

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.

## Question Set 1

1. What do you think is the “biggest” or “most important” question, and why?

2. For a long time, people were puzzled about why the night sky is dark. After all, if the Universe is infinite, then it probably contains infinitely many stars, so you might guess that the night sky should be very bright, which it isn't, of course! Let us hold onto the assumption that the Universe is infinite and contains infinitely many stars. How, then, might you explain this apparent paradox? *Hint: The speed of light is finite.*

3. I've often included the adjective “most” in stating Hubble's observation that “most of the galaxies we observe are currently moving away from us.” As a matter of fact, there are about 10 galaxies moving *towards* us (*i.e.*, towards the Milky Way). If the Universe started out in a Big Bang, causing all the matter and energy to fly *apart* from each other after it happened, then why might we suspect that eventually some of the matter and energy (which may have coalesced into galaxies by now) would start to move *toward* each other?

4. In class, one student suggested an interesting explanation of Hubble's observation that most galaxies are currently moving away from us. She hypothesized that perhaps we and all the galaxies we observe are being attracted by some kind of huge, massive *shell* that surrounds us (which we don't observe, for some reason; perhaps it isn't very bright). This clever hypothesis — which we shall call the Shell Hypothesis — sounds quite intuitive, since it's very easy to imagine each galaxy simply being pulled mostly by the portion of the shell closest to it, thereby causing most of the galaxies to move away from us. (Admittedly, the Shell Hypothesis seems to work best by assuming that we're at the center of the shell — an assumption an

objectivist scientist might be dubious of — but no matter; we are simply exploring this hypothesis for fun.)

For all of the intuitive legitimacy of the Shell Hypothesis, however, it couldn't possibly be right. Why? (Ignore the existence of the cosmic microwave background for this question.)

*Warning: Being confident with your answer to this question may require some understanding of physics beyond the zero understanding I'm assuming for this class. In particular, you should know that the force of gravity varies inversely with the square of distance. So, if you don't (yet!) know much physics, don't get discouraged by this question!*

**5.** On page 4 of Lecture Notes 1, I briefly mention an alternative to the Big Bang theory known as the steady-state model, which holds that matter and energy are spontaneously created as the Universe expands in time. This spontaneous creation of matter and energy may seem quite odd (or downright blasphemous, if you believe in the law of conservation of energy), but opponents of the Big Bang theory held that the actual “Bang” in the Big Bang is equally, if not more, crazy: what banged, why did it bang, and what happened before it banged? Which (for any reasons whatsoever) do you find less attractive: the “Bang,” or the spontaneous creation of matter and energy? (Ignore the fact that the steady-state model does not predict the existence of the CMB.)