Astronomy 160b — Spring 2007

Problem Set #9 — due April 26, 2007

Apart from the Type Ia supernovae, there are a number of other bright "standard candles" that could in principle be used to study cosmology. One of them is the "brightest cluster galaxy" (hereafter BCG). In this method, one looks at large clusters of galaxies, and uses the brightest of them as a standard candle. It turns out that if one controls for the size of the cluster, and some other factors, this works pretty well. A typical absolute magnitude of a BCG is -25. (Where needed, you can assume a Hubble constant of 70 in the usual units).

I (6 points). Some preliminary exercises in dealing with BCGs:

a) Assuming that the light from a BCG is made up of light from stars like the Sun, how many stars does a BCG contain? Recall that the absolute magnitude of the Sun is $+5$.

b) If a BCG is observed to have an apparent magnitude of 10, what is its redshift z?

II (6 points). There are some advantages to using BCGs as standard candles instead of using Type Ia supernovae — BCGs are brighter than SNe, and so can be seen more easily at large distances, and they don't appear and disappear, so you don't have to observe them at a particular time. On the other hand, the mass (and hence the luminosity) of large galaxies increases with time, as the larger galaxies absorb smaller ones. Therefore BCGs a long way away (observed as they were in the distant past) are systematically fainter than BCGs nearby.

a) Explain why this would be a serious problem for using BCGs for studying cosmology.

b) Suppose the observed magnitudes and redshifts of BCGs agreed with Type Ia supernovae out to $z = 1$, but when observed further away (out to $z = 2$ or so) implied a "Big Rip" cosmology. Explain why the problem noted above would *not* be able to explain this result.

III. (8 points). In class we briefly discussed two planned projects that propose to move our understanding of cosmology to the next level, namely SNAP and LSST. The SNAP website is at http://snap.lbl.gov and the LSST website is at http://www.lsst.org. Note that information about the LSST supernova project can be found by clicking on "for scientists" then on "Science", then on "Dark Energy" then on "supernovae" (or going directly to http://www.lsst.org/Science/sn.shtml) — as you'll see, they've got lots of other projects afoot, including several other approaches to the Dark Energy problem.

a) Suppose the financial resources only existed to support one of these two projects. Based on the information on the websites, and links from the websites, which of the two would you support, and why?

b) Funding agencies are very enthusiastic these days about web sites that are educational to the public. In terms of communicating science to the educated public (that's you) give each of these two sites a grade of 1-5 (1=poor, 5=excellent), describe their strengths and weaknesses, suggest ways they might be improved.