Astronomy 1143 Homework 3

November 15, 2015

1. Let's say that the ratio of the density of visible and dark matter to the critical density is $\Omega_m = 0.5$, and the ratio of density of dark energy to the critical density is $\Omega_\Lambda = 0.7$.

   (a) Is the overall density (matter and energy combined) of the universe greater or less than the critical density?

   (b) What shape would the universe be in this case?

2. The critical density of the universe today is related to Hubble's constant. If tomorrow the Hubble constant were measured to be 5% bigger than we think it is today, would this increase or decrease the critical density of the unvierse? By what factor? (Note: Looking for a multiplicative factor here, not the value of this new critical density!)

3. We saw before that a strong Lyman α emission line in a $z = 7.1$ caused the normally UV line to be seen in the near infrared, around $9841\mathring{A}$. Would such an object have a very blue or very red color in r - Y? Hint: the effective wavelengths of these bands are $7800\mathring{A}$ for r and $10000\mathring{A}$ for Y.

4. Why is it especially good to discover a Supernova Ia in a galaxy that also hosts lots of known Cepheid stars? What can these two things tell us?

5. Suppose you observe two supernovae Ia. Their distance moduli indicate that they are 1 Mpc and 2 Mpc away, and their redshifts yield velocities of 71 km/sec and 150 km/sec respectively. From these distances and recessional velocities, what type of expansion would you say the universe is undergoing? Is it undergoing a constant expansion, expanding at a decelerating rate (expanding more slowly now than it did in the past), or at an accelerating rate (expanding more quickly now that it did in the past)?