Astronomy 162 – Winter Quarter 2007
Homework #4

Due in class Wednesday, March 7

Instructions

This handout is just a worksheet. Homework answers must be turned in on the bubble sheets provided. You can pick up additional bubble sheets during class.

Using a #2 pencil only (no pens), please fill out the following info:

1. Your full name, **last name** first, first name last, and remember to bubble in the letters.
2. Bubble in your answers under questions 1-5 in the fields provided on the form.
3. There is no need to bubble in any ID numbers

Please turn in your homework in class on Wednesday, March 7. **No late homework will be accepted**.

This homework assignment consists of the 5 questions below + 1 extra credit problem at the end. The non-extra-credit problems have equal weight.

1) Assume that you live in a Universe with no cosmological constant (Ω_Λ=0). If you incorrectly measure the Hubble constant, H_0, larger than it is, what will happen to your estimate of the age of the Universe? If you get H_0 right, but incorrectly measure the amount of matter (Ω_m) to be larger than it is, what will happen to your estimate of the age of the Universe in this case? (Hint: in the second case, you will think that the Universe has decelerated much more than it actually has.)
   a) You will overestimate the age in the first case and underestimate it in the second case.
   b) You will overestimate the age in both cases.
   c) You will underestimate the age in the first case and overestimate it in the second case.
   d) You will underestimate the age in both cases.

2) You measure a redshift to a galaxy of z=0.05. Assuming H_0=70 km/s/Mpc, what is the distance to the galaxy (pick the closest answer)?
   a) 1.05×10^6 Mpc
   b) 1.05×10^9 Mpc
   c) 3.5 Mpc
   d) 215 Mpc

3) At what wavelength does the cosmic background radiation send out the most light (pick closest answer)? (Hint, remember the background radiation is a perfect blackbody with a temperature of 2.725 K, there are 10^7 nm in one cm, and there is an exceptionally helpful equation in Lecture 4.)
   a) 0.1 cm
   b) 1.0 cm
   c) 10 cm
   d) 100 cm

4) Why is it impossible for all the dark matter to be made out of hydrogen?
   a) The presence of relatively large amounts of deuterium
   b) The experimental detection of dark matter on Earth
   c) The observed emission of visible light by cold hydrogen gas
   d) The low rate of detection of MACHOS

5) According to current theories of galaxy formation, why are ellipticals the most common kind of galaxy in large, rich clusters?
   a) There is never much gas in clusters
   b) Mergers are common in clusters, turning spirals into ellipticals
   c) The dark matter in clusters turns galaxies into ellipticals
   d) Only ellipticals are massive enough to fall into clusters.

EXTRA CREDIT PROBLEM

When recession velocities become large (that is, when they approach the speed of light), we **cannot** use the relationship we have been using between redshift and velocity:

$$z = \frac{v}{c}$$

Instead we must use the special relativistic formula.

First, show that recession velocities do approach the speed of light in the Universe today.
1) Determine the redshift (z) when v=half of the speed of light
2) Use Hubble's Law to calculate the distance to an object at that redshift.
3) Translate that into light-years (1 Mpc=$3.26\text{x}10^6$ lightyears)
4) Compare the number of light-years to the Age of the Universe and conclude that this light would have had time to reach us. Therefore, we see objects receding at very high speeds.

The special relativistic formula illustrates that we can measure redshifts > 1, even though the speeds do not exceed the speed of light.

Using the equations in box 26-2, calculate the recession speed of a galaxy with z=5. Then use Hubble's Law to determine its distance. The last example in box 26-2 will be particularly helpful.