Prof. L. Sparke Astronomy 103 Name_____
Fall 2006 Disc._____

Homework 10: Due **Wednesday December 6, 2006**, in class (or turn them in before then to my mailbox, 5th floor, Sterling Hall). Show your working (for partial credit if you make an arithmetic error), and attach an extra sheet of paper if you need it.

1) Make a simple estimate of the time since the Big Bang. Assume that each galaxy has always moved at the same speed, and that Hubble's constant is H(now) = 20 km/sec/Mega-light-year (Mly), with V = H x d.
a) If a galaxy G is 100 Mly from us, how fast is G moving away, according to Hubble's law?

b) How many years does it take G to travel 100 Mega-light-years, moving at that speed? (You'll need to convert 100 Mly to kilometers.)

c) Now do the same calculation for another galaxy, G2, which is now 200 Mly from us. How fast is G2 moving away from us, according to Hubble's law? At that speed, how long would G2 take to travel 200 Mly?

d) How many years would you have to 'run the cosmic movie backwards' before G, G2 and the Milky Way were (almost) in the same place? This gives an estimate for the time since the Big Bang.

e) Is the motion of the galaxies likely to be slowing down, or speeding up, as time goes by? Explain what might cause the slow-down or speed-up.

f) Some people used to believe that H=30 km/sec/Mly. When they calculated the time since the Big Bang, did they find a longer or a shorter time, than you did in part (d)? Why?

g) Hubble's measurements of the speeds V of galaxies were pretty close, but his estimates for d were about 10 times too small. What would Hubble think that the distance to galaxy G was? What did he think H was?

h) What would he have found for the time since the Big Bang? Why did people say that this could not possibly be the correct age of the Universe?

i) According to Hubble's law, all the galaxies should be moving apart from each other--but the Andromeda galaxy is moving *toward* us, not away from us. Why?

2) Suppose the galaxies were moving away *from our Milky Way* with speeds proportional to the *squares* of their distances:

"Squbble's Law" $V = Sd^2$ with $S = 5$ km/sec/(Mly)^2

<--------3 Mly---------><------------4 Mly ------------>

* * *

A Milky Way B

= MW

Use Squbble's law to find how fast galaxy A would be moving away from us.

How fast would galaxy B be moving away from us?

Now, use the two speeds you just found to calculate what an astronomer in galaxy A would see. How fast are we (MW) moving away from A? How fast is galaxy B moving away from A?

Does Squbble's law work for an astronomer in galaxy A? Explain.

(Hubble's original measurements were not very good, he couldn't really tell from them that V was proportional to d and not d^2 or the square-root of d: but he believed that the Milky Way was not in a special place in the Universe, which told him that V had to be proportional to d.)