Week 2 Notes
Astro 2 (Discussion Section 102)

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Administrative Tasks

Crashing and Section Switching Those who attend section *and* are on the wait list will be given the first spots within a week or so. Those who are not on the wait list, but who have attended section will be given the next available spots. If you are trying to switch sections, don't come to me unless you have someone in the other section in particular with whom you want to switch. You are free to attend either section, so long as you turn in your homework and tests to the proper places. You will still be a member of whatever section appears in your GOLD account.

Homework Submission Reminder Homework is due Friday by 4:00. The stickers have been put on the submission boxes, so when you turn your homework in, look for the sticker with your section number on it (do you know your section number yet?!). Recall, the homework submission boxes are on the *left* entrance on the *right* wall. You submit to the *top* box and will get your homework *returned* to the lower slots. I will not hunt and peck for your assignments; you have been warned. Also, remember to use a staple if you have more than one page for your homework.

Review

Hubble's Law

Redshift We define the **redshift** of an object by

$$z = \frac{\lambda - \lambda_0}{\lambda_0}$$

Hubble's Law After many measurements were made in the early years of this century, it was found that distant galaxies are *all* moving away from us. This was found from looking at spectra of distant galaxies. Surprisingly, all the spectra were redshifted rather than blueshifted. In fact, they were redshifted in such a way that a plot of their receding velocity against their distance from us formed a linear graph. The slope of this graph is often called Hubble's constant, in honor of Edwin Hubble's contribution to the study, and **Hubble's Law** is often stated by the equation

$$v = H_0 d$$

where v is the recessional velocity of a galaxy and d is the distance to the galaxy. The units on H_0 define the units of d and v. Often we'll use $H_0 = 73$ km/s/Mpc. This behooves d being measured in Mpc and v being measured in km/s.

Example Suppose a galaxy has redshift of $z = .5$. What is the apparent magnitude of a star in this galaxy if its absolute magnitude is $+4$?

We'd like to use the distance modulus to find M. Thus, our first task is to find the distance to the galaxy. If $z = .5$, then $v = .5c = 150,000$ km/s. If we assume $H_0 = 73$ km/s/Mpc, then the distance is

$$d = \frac{v}{H_0} = \frac{150,000\,\text{km/s}}{73\,\text{km/s/Mpc}} \approx 2,000\,\text{Mpc}$$

Then using the distance modulus, we have

$$m = M + 5\log d - 5 = 4 + 5\log\left(2 \times 10^6\right) - 5 = +30.5$$

Blast From the Past: Kepler's Third Law

Recall Newton's form of Kepler's Third Law:

$$P^2 = \frac{4\pi^2}{G(m_1 + m_2)} a^3$$

where all units are understood to be in SI units.

Example: Suppose two galaxies are in orbit around each other, where galaxy A has mass $m_A = 1.4 \times 10^{42}$ kg and galaxy B has mass $m_B = 1.8 \times 10^{42}$ kg. If they are on average 900 kpc away from each other, how long will one orbit take?

Solution This is an application of Kepler's Third law on galactic scales. We can take Kepler's third law and solve for the period:

$$P = \sqrt{\frac{4\pi^2}{G(m_A + m_B)} a^3}$$

Plugging in our values, we get

$$P = \sqrt{\frac{4\pi^2}{(6.67 \times 10^{-11})(3.2 \times 10^{42}\,\text{kg})} (900 \times 3 \times 10^{19})^3\,\text{m}} = 1.9 \times 10^{18}\,\text{s} = 60\,\text{billion years}$$