Homework 1

Astronomy 202a

Fall 2009

Due September 23, 2009

Problems:

1. A galaxy has an integrated blue magnitude of 6.5, a rotation velocity (essentially flat) of 107 km s^{-1}, and is ellptical in overall shape with major and minor axes of 73'x43'. (a) Using Opik's method of estimating distances, what is the approximate distance to this galaxy?

   Another galaxy has a B magnitue of 9.27, a rotation velocity of 280 km s^{-1}, an apparent diameter of 8.7' and is essentially edge on. It is at a known distance of 16.7 Mpc. (b) What is its blue mass-to-light ratio in solar units?

   (Hints: You will need to correct the rotation velocity for inclination effects. You will also need to know the conversion between blue magnitudes and flux. See the course webpage for that information. *Explain any assumptions.*)

2. Write a program to do coordinate conversions between equatorial (celestial) coordinates, galactic coordinates and supergalactic coordinates. What are the galactic and supergalactic coordinates that correspond to 13.00^h $+28°$? 5.50^h $-10°$? 12.45^h $+12.9°$? (attach your program in the solution)

3. The NFW Profile (Navarro, Frenk and White 1996, ApJ 462, 563) is the most commonly used modern density profile for galaxies and is based on the results of CDM simulations:

$$\frac{\rho(r)}{\rho_{crit}} = \frac{\delta_c}{(r/r_s)(1+r/r_s)^2}$$

   where $r_s = r_{200}/c$ is a characteristic radius and $\rho_{crit} = 3H^2/8\pi G$ is the cosmological critcal density, and δ_c and c are two dimensionless parameters. This profile is linked to the critical density. The mass of the so described halo is

$$M_{200} = 200\rho_{crit}(4\pi/3)r_{200}^3$$

and the definition of r_{200} is that the mean density within r_{200} is $200\rho_{crit}$, with

$$\delta_c \;=\; \frac{200}{3}\frac{c^3}{[ln(1+c) - c/(1+c)]}.$$

δ_c can be considered the characteristic overdensity of the halo, r_s is its scale radius, and c is its "concentration."

What is the surface brightness profile predicted from this density profile if you assume M/L = constant? (Remember you have to integrated the projected radial density along the line of sight). How does the shape of this profile differ from a deVaucouleurs $r^{1/4}$ law profile? (Plot your results).

4. The bulge-to disk ratio for a spiral galaxy is the ratio of the luminosity in the bulge to that in the disk. Typically bulge-to-disk ratios decrease with increasing (later) morphological type.Calculate the bulge-to-disk ratio for a typical spiral galaxy with a de Vaucouleur's Law bulge and an exponential disk as a function of the variables r_s, r_e, I_S and I_e. Remember

   For Ellipticals:
   $$I(R) = I_e e^{-7.67((r/r_e)^{1/4}-1)}$$

   For Spirals:
   $$I(R) = I_S e^{r/r_s}$$