Homework 5

Astronomy 202a

Fall 2009

Due November 20th, 2009

Problems:

Problem 1.Timing Arguments

1. Finish out the Kahn & Woltjer timing argument for the Local Group discussed in class. The measured velocity difference between M31 and the center of the MW is -118 km/s (they are coming together) an the current separation is 770 kpc. Assume an age for the Universe of 13.7 Gyr. Derive the LG mass assuming they are on their first pass. What is the "phase angle," θ of the orbit? How much does this change if they are in fact on their second pass?

2. The same argument can be applied to to the MW-LMC system to derive an estimate of the mass of the combined system (mostly the MW). The relative galactocentric velocity is 84 km/s and the separation is now 51 kpc. What is the MW mass? (N.B. Here it is more likely that the LMC has gone around more than once.)

Problem 2. Cluster Structure The Coma Cluster is the nearest large galaxy cluster and as such has been fairly extensively studied spectroscopically. On the course website you can find a large data file containing positions and velocities for galaxies in the general direction of the cluster.

http://www.cfa.harvard.edu/ huchra/ay202/comasurvey.dat

1. Find the cluster centers derived from a luminosity weighted mean and the number weighted mean. Explain your assumptions and your methodology.

2. Derive the projeced radial number and luminosity density profiles and determine the 3-D radial luminosity profile using the techniques discussed in class.

3. Extra credit: Plot the cluster isopleths scaled to the mean galaxy density in the surveyed area.

N.B. The data file for this problem is much larger than for the virial problem of HMW2 and covers a much larger area.

Problem 3. Correlation Functions The simplest correlation function to calculate is just the angular two-point CF, $\omega(\theta)$:

$$\delta P \;=\; N[1+\omega(\theta)]d\Omega$$

where δP is the excess probability of finding a galaxy at angular separation θ from any galaxy, N is the mean surface density of galaxies, and $d\Omega$ is the solid angle element.

Using the same data file as above, calculate and plot the angular two-point CF over scales from 0.1 to to 10 degrees.

Remember to take into account edge effects! That is to say, for galaxies in the sample near the edge of the survey boundary when calculating the expected number of galaxies at any given radius you must take into account area missed due to the survey's spatial limits. The spatial limits of this sample are given in the file header. This is actually the hard part of the problem! Explain your approach.

Problem 4. Cluster Gas Metallicity As discussed, one way of bringing the metallicity of the cluster gas up to 1/4 Solar is by winds from the galaxies of enriched material from stars driven by stellar mass loss. The Sun's mass loss rate is 2×10^{-14} $M_\odot$ per year, way too small. What would the *average* mass loss rate for the stars in a cluster need to be to bring a primordial gas halo of typical mass up to 1/4 solar? Assume the winds are solar metallicity.

You will need to estimate the number of stars in the galaxy cluster. You should also make some other assumptions about the stars and about the total gas mass and primordial gas mass. For simplicity, assume all stars are the same.

Why does this number either make or not make sense?