Ay 127 – Winter 2017

Homework #2

Posted on Feb. 17, due by 5 pm on Fri. Feb. 24 (directly to your TA)

The honor system applies as follows: You can discuss the problems among yourselves, how to go about them, but not derive the solutions jointly – everyone should work out their own solutions.

Problem 1 [4 points total, 2 each]:

a. A cluster of galaxies is observed at a redshift cz = 5000 km/s. You are using a distance indicator whose zero-point which may vary by up to 20% in different environments. What is the expected magnitude of a spurious peculiar velocity you may measure for this cluster?

b. You are surveying the volume out to cz = 3000 km/s. Assume that the typical peculiar velocities are of the order of 500 km/s. What precision of distance measurements do you need in order to have the peculiar velocities (not distances!) measured with a typical accuracy of 10% or better? How likely do you think this is, and why?

Problem 2 [10 points total]:

Consider a cluster of galaxies with a radial velocity dispersion σ = 1500 km s^{-1}, and the mean radius $\langle R \rangle$ = 1.5 Mpc. It contains approx. 500 galaxies, with a mean luminosity $\langle L \rangle = 10^{10}\, L_{\odot}$.

a. What is the estimated mass of the cluster? [3 points]
b. What is the mass-to-light ratio, in Solar units? [3 points]
c. What is the temperature of the intra-cluster gas (assume a pure hydrogen)? [2 points]
d. What is the typical energy and wavelength of emitted photons (explain)? [2 points]

Problem 3 [6 points total, 2 each]:

What would be the form of the galaxy 2-point correlation function if:

a. Galaxies were distributed uniformly in space?
b. All galaxies were on sheets/walls?
c. All galaxies were in filaments?

Problem 4 [20 points total]:

Assume that we live in an Einstein – de Sitter universe with $\Omega_m = \Omega_0 = 1$, and $h = 0.5$.

a. Derive the formula for the free-fall time as a function of the object's mass M, and the initial radius R. Recall that it is approximately equal to ¼ of the orbital period at that radius. [6 points]
b. Consider a typical disk galaxy like the Milky Way, with a flat rotation curve with V_{circ} = 220 km s^{-1}, and a halo extending out to R_{max} = 50 kpc. What is the total mass of this galaxy? [5 points]
c. If it formed via a dissipationless collapse, what was the free-fall time? [4 points]
d. Assuming the same Einstein – de Sitter model as above, how old was the universe when this galaxy formed, assuming that it started right after the big bang? [5 points]