

Homework 4

Astronomy 202a

Fall 2009

Due November 4th, 2009

Problems:

Problem 1. Malmquist Bias The H_0 Key project has measured distances to a number of nearby galaxies:

<http://www.cfa.harvard.edu/huchra/ay202/homework/key.dist.dat>

By definition, one could calculate a Hubble Constant by fitting these distances to a relation versus redshift. This isn't correct. Why? Describe how you would correct the redshift distance plot for these galaxies for the distance-error "flavor" of the Malmquist bias. Estimate H_0 for the data. What other effects are important? (You will need to look up redshifts for the galaxies. There are a number of sources. Justify your choices).

Problem 2. Gravitational Lensing A new, bright, two image gravitational lens has been found (separation=2.1", $z_{\text{lens}} = 0.6$, $z_{\text{source}} = 2.2$, component A is 0.7" from the center of the lensing galaxy and component B is 1.4"), and old observations from the Harvard plate stacks indicate that there is a time delay of 1 year between component A and B. Estimate the distance of the lens? What simplifying assumption do you need to make?

Problem 3. Galaxy Formation From just the Jean's model, what is the Jeans mass at a redshift of 100 if the universe has its current matter density ($\Omega \sim 0.25$)? At a redshift of 10? Assume that the Universe has not reionized and that the IGM has cooled adiabatically since it was last in thermal equilibrium with the CMB at $z=1000$.

Problem 4. Quasars The quasar SDSS J1148+5251 at $z = 6.42$ has a bolometric luminosity of $10^{14} L_{\odot}$. At this redshift, the age of the universe is approximately 0.85 Gyr. If the quasar is powered by accretion onto a supermassive black hole with an efficiency of 10%, what are the minimum and maximum masses that the black hole can have and what creates these limits? If the black hole mass has its minimum value, for what fraction ϵ_{DC} of the age of the universe must the quasar have been active? Given that there is a relation between the velocity dispersion of the host galaxy and the black hole mass, with what other observational constraint must the black hole mass and ϵ_{DC} be consistent? Explain.