Final Exam

Astronomy 202a

Fall 2009

Due December 14th, 2009 5:00 P.M. EST in P309

Open note, book. Please avoid the web unless you need to access any datasets required for the problems. Work independently.

Problems:

Problem 1. Galaxy Classification On the course website at
http://www.cfa.harvard.edu/∼ huchra/ay202/galaxies
there are fits images of twenty galaxies. Classify them according to the standard Hubble/Sandage/deVaucouleurs system (E/S0/Sa/Sb/Sc/Sd/Sm/Im). For this problem, do not use the web or any catalog resource. These are fits format images so can be examined using DS9 which is available on CfA CF machines. It is also possible to open fits images in Mathematica.

Problem 2. Galaxy Magnitudes A disk galaxy has an observed central surface brightness of B = 21 magnitudes per square arc second and a disk scale length of 8 kpc. It is at a distance of 10 Mpc. (a) What is its apparent magnitude inside the B = 25th magnitude per square arcsecond isophote? (b) What is its absolute magnitude?

Problem 3. Color Evolution For a SSP (Simple Stellar Population) model with a Salpeter IMF, how do the UBV colors evolve with time? Use the Basic Stellar Data table from PS6, but don't worry about evolution off the main squence. Interpolate and extrapolate as necessary. (Plot your results as well as tabulate them).

Problem 4. Galactic Structure What is the expected radial velocity along the l.o.s. as a function of distance for stars in the disk of the Milky Way at galactic longitudes of 30° and 60°? Plot your results for $0 \leq d \leq 20$ kpc.

Problem 5. Stromgren Spheres FA new star cluster is born with a Salpeter IMF that has an upper mass bound 130 $M_\odot$, and an almost zero age burst of star formation of total

mass 10^5 $M_\odot$. It is situated in a gas cloud of density $N_H = 1$ atom/cc. What is the size of the resulting HII region assuming that the region is ionization bounded? Hint: Figure out the approximate number of O3, O5, ... etc. stars that get formed and count UV photons.

Problem 6. Oort Limit One of Jan Oort's many contributions to stellar dynamics was to estimate the surface mass density of the galactic disk (in $M_\odot/pc^2$) by measuring the stellar density as a function of height z above the plane and measuring the vertical stellar velocity dispersion. If a population of stars has a vertical dispersion of 20 km/s and a scale height of 300 pc what is the estimate of the surface mass density of the disk?

Problem 7. Timing Argument The Kahn & Woltjer timing argument was derived for radial orbits. Suppose we add tangential motions (angular momentum) to the problem. Revisit the LMC question of PS5 adding in the recently determined proper motion of the LMC: μ_W=-2.03+/-0.08 mas yr^{-1}, and μ_N =0.44+/-0.05 mas yr^{-1}. Remember that the radial velocity is 84 km/s w.r.t. the Galactic Center and the separation is 51 kpc.

Problem 8. Expansion Parallax Nova Cygnus 1909 is now observed to be 20" in diameter. Its initial expansion velocity was observed to be 1000 km/s but that velocity has been dropping linearly with time and is now only 400 km/s. How far away is it?

Problem 9. AGN A quasar is observed to have emission lines that are 30,000 km/s wide, exhibits variability characterized by a one month timescale and has an absolute magnitude (Bolometric) of -27. Is it radiating near its Eddington Limit? Why?

Problem 10. Supercluster Infall We have observed an infall velocity of 300 km/s of the Local Group towards the Local Supercluster which is centered approximately on the Virgo Cluster. On the class website is a data file of all galaxies within 2500 km/s

http://www.cfa.harvard.edu/∼huchra/ay202/lsc.dat

Use this data to *quickly* estimate the overdensity of the Supercluster inside the Local Group sphere (i.e. the sphere of radius LG to Virgo centered on Virgo) and thus estimate Ω_M. Virgo is at α= 12h 30m 50.6s $\delta = +12°$ 23' 30" and is at an average heliocentric velocity of 1170 km/s. To estimate the LSC overdensity inside the LG radius you need to make a small number of simple assumptions. What are they?

Hint: There is an easy way to estimate $\delta\rho/\rho$ for the LSC and a hard way. Use the easy and quick way! And remember its $\delta\rho$.

Problem 11. What are the three most important things you have learned in this class? For fun, the three most useless!

Thank you for taking part in Astronomy 202a.