PHYS 321: PROBLEM SET 9

Due May 2 @ 02:30 pm

1. (2 credits) Using Shapley's assumption that M101 has a diameter of 100 kpc, and adopting van Maanen's flawed observation of a measurable rotational proper motion ($0.02''$ yr^{-1}), estimate the speed of a point at the edge of the galaxy and compare it to the characteristic rotation speed of the Milky Way.

2. (4 credits) NGC 2639 is an Sa galaxy with a measured maximum rotational velocity of 324 km s^{-1} and an apparent magnitude in B (blue) band of $m_B = 12.22$ mag (after making corrections for extinction).
   (a) Estimate its absolute magnitude in the B band from the Tully-Fisher relation (use the relation with appropriate constants found in your textbook). What is the luminosity of the galaxy in the B band? Express you answer in terms of solar luminosity $L_\odot$. Hint: It is most straightforward to compare your result with the absolute magnitude of the Sun at B band.
   (b) Determine the distance to NGC 2639 in Mpc.
   (c) Use the rotational speed to find the mass of NGC 2639 that is interior to $R_{25} \approx 26.8$ kpc (this is defined as the radius at a surface brightness level of 25 B-mag arcsec^{-2}). Please express your answer in terms of solar mass $M_\odot$.
   (d) Calculate the mass-to-light ratio for NGC 2639 in the B band (use the mass interior to R_{25}). Note your results should be expressed in terms of $M_\odot/L_\odot$ (which is unity by definition).

3. (4 credits) In 1921, Astronomer Edwin Hubble was measuring the speeds and distances of nearby galaxies (see table below), when he noticed an interesting trend when he plotted the speed of the galaxy against its distance, now known as the "Hubble's Law".

Galaxy	Distance (Mpc)	Speed (km/s)
NGC-5357	0.45	200
NGC-3627	0.9	650
NGC-5236	0.9	500
NGC-4151	1.7	960
NGC-4472	2.0	850
NGC-4486	2.0	800
NGC-4649	2.0	1090

   (a) Please use your favorite programing language to convert Hubble's measurements to your own speed-distance diagram similar to Fig. 27.7 in your textbook.
   (b) Use a linear regression method to fit the data points to a function with the form $v = H_0 d$. Find your best fit value of H_0 in km s^{-1} Mpc^{-1}. Why is his result so different from today's value ($H_0 = 71$ km s^{-1} Mpc^{-1} from WMAP)?