PHYS 321: PROBLEM SET 9

Due May 2, 2018 Wed @ 11:30 am

*Solve the problems listed below, and **write up your answers clearly and completely**. Do not turn in rough work – instead, make a clean copy after checking your calculations. Use English sentences and phrases to explain your solution and describe your answers step by step. Even if you did not get the correct answer, you may get partial credits for these steps!*

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. (5 credits) NGC 2639 is an Sa galaxy with a measured maximum rotational velocity of 324 km s^{-1} and an apparent magnitude in B band of $B = 12.22$ 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).
   (b) Determine the distance to NGC 2639 using its distance modulus.
   (c) 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}?
   (d) What is the luminosity of the galaxy in the B band? Be sure to include M_B for the Sun in your calculations, not M_{bol}. See Appendix: Stellar Data for the value.
   (e) Calculate the mass-to-light ratio for NGC 2639 in the B band (use the mass interior to R_{25}).

3. (3 credits) Collision or not?
   (a) The mass density of stars in the neighborhood of the Sun is approximately 0.05 $M_\odot$ pc^{-3}. Assuming that the mass density is constant and that all of the stars are main-sequence M0 stars, estimate the fraction of the Galactic disk's volume that is occupied by stars. (Hint: Using Appendix G to find out mass and radius of individual M0 stars.)
   (b) Suppose that an intruder star (a main-sequence M0 star) travels perpendicularly through the Galactic disk. What are the odds of the intruder colliding with another star during its passage through the disk? Take the thickness of the disk to be approximately 1 kpc. (Hint: Make use of the definition of mean free path with the cross-section given by the size of the M0 star, and note that the mean free path is really the distance it travels to make one count of collision.)