ASTRONOMY 020

Problem Set #21

Due: March 26, 2004

1. Derive expressions for the enclosed mass $m(r)$ and local density $\rho(r)$, as functions of radius r and a spatially constant rotation speed v_0, in the outer part of our Galaxy. Assume a spherical mass distribution for simplicity. The required $\rho(r)$ must be provided by some unknown dark matter.

2. Use the Galactic rotation curve in Figure 20-8 to find the time it would take a star at $R = 5$ kpc to make one more revolution around the Galaxy than the Sun, located at $R = 8.5$ kpc. Assume circular orbits. A spiral arm between these radii would be wound up one turn in this time. Use your answer to argue why the spiral pattern must be caused by some mechanism other than differential rotation.

3. Use the rotation curve in Figure 21-9 in your textbook to estimate the mass of NGC 4378.

4. You observe two elliptical galaxies with projected aspect ratio $a/b = 2$.
   (a) What is the ellipticity of the two galaxies?
   (b) Do you believe the two galaxies must have the same intrinsic three-dimensional shape? Explain your reasoning.

Practice problems:

1. Write down a scenario for the formation and evolution of our Galaxy that accounts for the existence of as many features of our present day Galaxy as possible.
   Answer: see class notes.

2. Zeilik and Gregory, Chapter 21, problem3.
   Answer: 1 "galsec" $= 1.75 \times 10^9$ pc. Though observable in principle, this parallax would take 110 Myr to measure!

3. Zeilik and Gregory, Chapter 21, problem 8.
   Answer: Large amounts of dust cannot account for the high M/L ratio since we would be able to detect it in the usual ways, i.e., through reddening and extinction of light from background stars, and emission at infrared wavelengths.