AY 145: HW 10

Due Monday, May 9th

1. **Rotation Curves & Spiral Structure**

   One classic issue in astronomy is the difference between the expected Keplerian falloff in rotation velocity as a function of radius (the rotation curve of a galaxy) and the actual observations.

   (a) Calculate the expected rotation curve for a disk of finite thickness (lets say axial ratio of 10 to 1) and constant density as a function of radius. Calculate the curve out to 10 disk radii, normalize r by the disk radius. To make the problem more concrete, assume the disk radius is 10 kpc and the surface mass density is 75 $M\odot/pc^2$ (like the Milky Way). Plot v(r) versus r, and assume circular orbits. The disk is rotationally supported.

   (b) How much different is the mass of this Keplerian disk from a disk of the same total size (100 kpc) that has a *flat* rotation curve with a velocity that is the peak of the v(r) you calculated above? This is the dark matter problem.

2. **Galaxy Population Evolution** Suppose a galaxy is very young and has just formed stars with a Salpeter IMF (Initial Mass Function), slope

$$\frac{dN}{dM} = M^{-2.35}$$

   (a) Using just our early list of stellar types versus mass, calculate the U-B and B-V colors of this initial burst of star formation.

   (b) Now suppose 5×10^9 years (5 Billion years) have passed so all the hot, more massive, stars have evolved away. Neglecting the contribution from red giants and other stars evolved off the main sequence, what is the color of the galaxy now?

   Information on the average colors of stars of different spectral types and messes can be found in Johnson's classic 1966 paper in the *Annual Reviews of Astronomy and Astrophysics* or in the more modern Astrophysical Quantities (Cox et al.).

   Hint: you also should make your integration continuous — set up bins around each mass/spectral type in your input table to produce a continuous mass distribution. Use your judgement here.