

Stars & galaxies, example class 2

Question 1. Short questions

1. What is the ‘rotation curve’ of a spiral galaxy? Derive the rotation curve for a Keplerian disk.
2. Describe two key observations that suggest the presence of dark matter in the Milky Way.
3. Explain the winding problem for spiral arms in a disk galaxy.

Question 2. Galaxy rotation curves

1. Show that the density profile that corresponds to a flat rotation curve is $\rho(r) \propto 1/r^2$.
2. The circular velocity for the Milky Way is $V_c = 220 \text{ km s}^{-1}$. Compute the (dark) matter density at the position of the Sun, $r = 8.5 \text{ kpc}$.
3. Assume the bulge of the MW has uniform density, ρ_b , mass $M_b = 10^{10} M_\odot$ and radius $r_b = 2 \text{ kpc}$. Calculate the effect of the bulge on the rotation curve, and sketch $V_c(r)$.
4. For those bulge parameters, re-calculate the matter density at the position of the Sun.
5. Most observed rotation curves rise linearly with r , close to the centre, $V_c(r) \propto r$. What does this imply for the density profile there?
6. Compute the period of the Sun’s orbit around the Milky Way centre.