

## Homework 6

Due **March 15 at 10:45am via Canvas**

Please show all work, writing solutions/explanations clearly, or no credit will be given. You are encouraged to work together, but everyone must turn in independent solutions: do not copy from others or from any other sources.

1. Our galaxy, the Milky Way, has a steeply rising rotational velocity near the center but quickly flattens out to 235 km/s. The bulge of the Milky Way has a radius of 2 kpc and a mass of 20 billion solar masses. Assuming constant mass density in the bulge, entirely made of baryonic matter, what is the maximum rotational velocity of the galaxy due to the material in the bulge? At larger radii, the density of the disk is significantly larger than the bulge. In fact, at a radius of 10 kpc, the mass of the disk is equal to the mass of the bulge. What would be the rotational velocity at 10 kpc if the Milky Way were composed of only the baryonic matter in the bulge and the disk? Given that the true rotational velocity at 10 kpc is 235 km/s, what mass of dark matter must be contained in a halo of radius 10 kpc? What is the ratio of matter to dark matter at this radius?
2. The Draco galaxy is a dwarf galaxy within the Local Group. Its luminosity is  $L = (1.8 \pm 0.4) \times 10^5 L_{\odot}$  and half its total luminosity is contained within a sphere of radius  $r_h = 120 \pm 12$  pc. The red giant stars in the Draco galaxy are bright enough to have their line-of-sight velocities measured. Their measured velocity dispersion is  $\sigma_r = 8.5 \pm 2.0$  km s<sup>-1</sup>. What is the mass of the Draco galaxy? What is its mass-to-light ratio? (Be sure to propagate errors and include them in your answers.) Describe the possible sources of error in your mass estimate of the galaxy.
3. **Presentation Prep:** Make an appointment to meet with me (via email: wik@astro.utah.edu) to discuss potential topics/papers for your end-of-semester presentation; the meeting should occur **next week** but should at least be arranged by March 16 for full credit. Identify at least one scientific paper your presentation could be based on and bring it to the meeting (you do not have to commit to that paper at this time). Be prepared to answer basic questions about it and—ideally—bring questions of your own.

My availability (subject to change):

- (a) 3/15: 10am-6pm
- (b) 3/16: 3-4pm, 5-6pm, 2-3pm (*office hours, only if free*)
- (c) 3/17: 10-11am, 11am-12pm (*office hours, only if free*)
- (d) 3/18: 12:15-1pm, 2-4pm
- (e) 3/19: 10am-6pm