# Astronomy 128: Galaxies and Galactic Structure

Week 10, Thursday, March 30

**Topic:** Elliptical Galaxies II:

This week we finish up our discussion of elliptical galaxies. We'll see that our initial impression of their gas content (little or no HI or $H_2$) isn't the whole story: they have lots of very hot, x-ray-emitting gas. We'll also see that ellipticals typically hang out in the centers of galaxy clusters while spirals stick to the more remote suburbs. We'll finish off with different methods for determining cluster masses, including X-ray luminosity and gravitational lensing. Both seem to indicate that dark matter is even more prevalent in clusters than in individual galaxies: $\mathcal{M}/\mathcal{L} \sim 300$.

**Break:** Michael

**Reading:** Finish reading Chapter 6 of Sparke & Gallagher, Section 6.3 to the end.

**Problems:**

**NOTE:** I've been thinking more about the problems from Sparke & Gallagher, and the fact that sometimes they may seem more like exercises in algebra than problems that aid in conceptual understanding. I think that this may partly come from taking them out of context, though; in general, I think that many of them *do* help to illustrate concepts from the text, as long as you think about what the result of the problem means in the context of the reading that comes before it. Thus, I'm implementing a new requirement for all of the SG problems we do for the rest of the semester. Each time I assign a problem from SG, I'd like you not only to present the solution to the problem, but also to give a few sentences of explanation of what that numerical or algebraic result *tells* you about the topic at hand. If you can't figure it out after some thought, then come talk to me, just as you would if you couldn't solve the problem itself.

1. Come to class with at least one *written* question on the reading.
2. Compare the spectrum of an elliptical galaxy in SG Figure 6.17 to the various stellar spectra shown in Figure 1.1, and explain:

(a) What spectral types of stars must be present in the galaxy, and how you know;

(b) What it can't be one single spectral type that is dominating the light from the galaxy.

You'll want to look at both the overall shape of the spectra, and the specific spectral lines.

3. On p. 260, SG say that most Type Ia supernovae occur after 1 Gyr or more, while Type II supernovae get going right away. Explain why this is the case.

4. Again on p. 260: "Since all the [globular] clusters are fairly old, the bluer ones are probably poorer in metals." Why is the first qualifying clause necessary in this sentence?

5. SG 6.12. Also show that gas of this temperature (for a typical value of $\sigma$) will emit x-rays. Remember: see the note above on contextual explanation for all SG problems from now on.

6. SG 6.13.

7. Why does the gas in elliptical galaxies get heated to such high temperatures, but the same thing does not happen in spiral galaxies?

8. Why is it harder to search for dark matter in elliptical galaxies than in spiral galaxies?

9. SG 6.17. How does the black hole mass used here compare to the mass of the Milky Way's central black hole?

10. SG 6.19.

11. SG 6.20. What conditions/assumptions are necessary for the virial theorem to hold? In this problem, and problems that follow, please numerically evaluate all answers containing $h$. It's useful to see the $h$ dependence explicitly, but we know $H_0$ pretty well these days, so it's also useful to see the real numbers.

12. SG 6.23.

13. SG 6.24.