Astronomy 128: Galaxies and Galactic Structure

Week 5, Thursday, February 16

Topic: The Local Group

This week, we'll move out a bit and look at the galaxies in our own cluster of galaxies, the Local Group. We'll start off with a census of the types of galaxies present. We'll then look at how tidal forces from the larger galaxies (Milky Way and Andromeda) affect the smaller ones. Lastly, we'll examine the current best theory of how the Local Group formed and look at a model for chemical enrichment.

Break: Micah

Reading:

Read all of Chapter 4 of Sparke & Gallagher.

Problems:

1. Come to class with at least one *written* question on the reading.
2. I'd like to continue with us taking a look at some current papers in the literature that are related to the week's topic. This week, let's consider the long-standing issue of determining an accurate distance to Cepheids in the LMC in order to calibrate their period-luminosity relation precisely. Take a look at the paper "Direct Distances to Cepheids in the Large Magellanic Cloud: Evidence for a Universal Slope of the Period-Luminosity Relation up to Solar Abundance", by Gieren et al. (2005, ApJ 627, 224). I'd like everyone to read the introduction (which lays out the background of the problem pretty well) and the conclusion. Also look at some of the figures to get a sense of how tight the period-luminosity relation is. Finally, take the distance modulus and its uncertainty given in the abstract, and convert it to a distance (in kpc) and uncertainty. I'd also like one person to read the paper in somewhat more detail, and give a 5–10 minute overview of the paper during seminar. Vernon is off the hook since he reported on a paper last week. Volunteers?

3. Do problem 4.3. Now, consider the James Webb Space Telescope (JWST). The plan is to put the JWST at the L2 Earth-Sun Lagrange point. How far away will this be, compared to the Moon's distance? Given that JWST will primarily be an infrared telescope, it would be *really* nice if it was completely in the Earth's shadow. Will it be? If not, what fraction of the sun will be blocked by the Earth?

4. SG 4.5.

5. SG 4.6.

6. SG 4.7.

7. SG 4.9.

8. SG 4.10.

9. SG 4.12.

10. Adopt a galaxy! Choose one of the Local Group member galaxies (other than the Milky Way) and search the literature and/or the web to find (a) one or more images of the galaxy, perhaps at different wavelengths; and (b) a color-magnitude diagram of the galaxy.

11. Andromeda is on a collision course with the Milky Way. The calculations presented in SG Chapter 3 suggest that there won't be many collisions of stars, but we can still ask what it would look like for an astronomer in the far future.

    (a) Using data available in the textbook, compute the surface brightness (in $\mathrm{mag} \cdot \mathrm{arcsec}^{-2}$) for Andromeda's bulge. Compare this with the surface brightness of background light pollution in typical urban skies: $18\ \mathrm{mag} \cdot \mathrm{arcsec}^{-2}$.

    (b) Astronomers can obviously measure surface brightnesses as low as $26.5\ \mathrm{mag} \cdot \mathrm{arcsec}^{-2}$, since this is now the Holmberg Radius is defined (see section 1.3.1). If the darkest sites have sky surface brightnesses of about $22\ \mathrm{mag} \cdot \mathrm{arcsec}^{-2}$, how is it we are capable of seeing a galaxy all the way out to its Holmberg Radius (and beyond)?

    (c) Now suppose it is far in the future and Andromeda is only 15 kpc away. What is the surface brightness now? What is the apparent magnitude of the entire bulge? What would it look like from downtown Philadelphia (assuming light pollution hasn't gotten worse) and at a really dark site (again, assuming they exist)?