Topics: The Milky Way Galaxy

Summary of reading:

- Read sec. 1 of Ch. 19.
- Read secs. 2 and 7 of Ch. 19.
- Skim secs. 3 through 6 of Ch. 19.

Summary of work to submit:

- Nothing to submit for Tuesday's class.

Here are the things you should be thinking about:

The Milky Way is a relatively typical large spiral galaxy. And we happen to live inside it. Galaxies are the environments in which stellar evolution and material and energy exchange with the ISM takes place. They are gravitationally bound collections of stars, gas, dust, and – importantly – dark matter. The Milky Way has distinct populations of stars (metal rich vs. metal poor and those two properties correlate in meaningful ways with other properties of the stellar populations), and a relatively ordered structure (flattened disk with some spherical components) and kinematics (disk components orbit the galactic center; spherical components of the Milky Way have much more random, low angular momentum orbits).

Commentary on the reading:

You will learn from reading Ch. 19 that we only realized that the Milky Way is a galaxy – that other galaxies exist too – about a hundred years ago.

In the first section you'll see how the basic idea of star counting can help us figure out how big the Galaxy (capital G when we're talking about the Milky Way) is and where we're situated in it. However, interstellar dust is a huge problem. Note that globular clusters exist (look up a few images on APOD) and because they're not generally in the plane of the Galaxy, where most of the dust is, they were very helpful for figuring out the size and scale of the Milky Way (in the 1920s).

View of a portion of the Milky Way from Chile – http://apod.nasa.gov/apod/ap160707.html. Can you see how a flat, cylindrical distribution of stars would look like this when viewed from the inside?

Also pay special attention to the division of the Milky Way into disk, bulge, and halo and to the distinction between population I and population II stars. This is all mostly on p. 437.

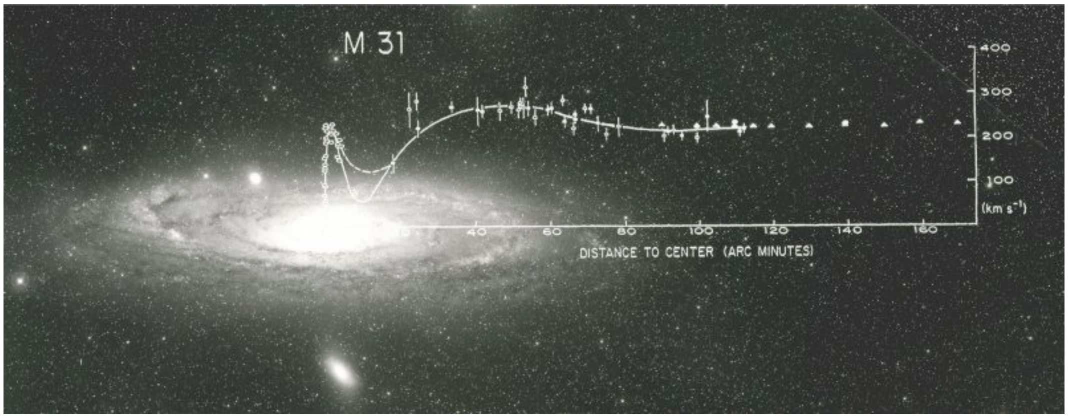
Finally, back to globular clusters. It's thought that all the stars in a globular cluster formed at the same time, and so they're the same age as each other (and basically the same distance from us). So, what do you think an HR diagram of all the stars in a globular cluster looks like? How would the HR diagram differ between a 1 billion year old globular cluster and one that's 10 billion years old?

The globular cluster Omega Centauri – http://apod.nasa.gov/apod/ap160427.html – note that it is estimated to be 12 billion years old, but that there are hints that not all the stars were formed at the same time.

For section 2, note: Kepler's third law – very useful here, as it is for satellites, exoplanets, and binary stars, because the gas, dust, and stars in the Milky Way are all independently orbiting (in more-or-less circular orbits) the center of the Galaxy. Make sure you're very comfortable with the concept of the *rotation curve* (as shown in Fig. 19.7) and how it, plus Kepler's third law (eqn. 19.13) allows us to not just weigh the Galaxy but trace out the radial distribution of mass in the Galaxy. This is our first encounter with *dark matter*. Make sure you understand how the flat rotation curve (plus observations of how luminous matter (stars) is distributed in the Galaxy leads us to infer that our Galaxy is full of dark matter). This dark matter is not (primarily) stars, planets, or neutrinos. It appears to be a yet-to-be-directly-detected type of heavy subatomic particle.

Skim sections 3, 4, 5, and 6 – *but* note the definition of proper motion (vs. three-dimensional space motion) and the concept of the local standard of rest (in our rotating galactic disk).

Finally, read §19.7 on the nucleus (center) of our Galaxy, focusing on the evidence for a supermassive black hole (SMBH) residing there. You can go to APOD and look at a few images of the galactic center. See if you can find a time-lapse version of Fig. 19.23, showing how the stars around the SMBH move.



The Andromeda Galaxy with its rotation curve superimposed to scale. If the mass were concentrated at the center, like the starlight is, then the orbital velocity of gas clouds would fall off with distance from the center of the galaxy, just as planets' orbital velocities decrease with distance from the Sun in our solar system. This figure is courtesy V. Rubin.