

The Milky Way, 20 November 2013

1. The "milky way" has two different meanings which you have to pick up from context:

A. It is our local galaxy of 300-400 hundred billion stars.

a. It is hundreds of thousands of light years across, much bigger than any other object discussed in this class so far.

1. One light year is about 10 trillion kilometers.

2. Our galaxy is large compared to our solar system, but it is a small part of a local group of clusters, which is a small part of a local super cluster, which is a small part of the visible universe.

B. It is also a milky path of light running through the sky around the celestial equator.

a. No one ever thought the milky way was made of milk, it just looks milky.

b. The milky way isn't bright enough to be seen in areas of light pollution like cities.

c. The milky way appears as a disk with a thick bulge 20 degrees above and below it at its thickest. Other areas have much less of the bulge.

1. This part of the milky way looks the brightest.

2. In full sky pictures of the milky way, the bulge is often at the center of the picture.

3. Though the center of bulge tends to look like the only bright place in an image, there is an area around it with fainter stars.

A. You can see the true extent of the milky way by comparing the brightness of the area around it with dark space farther away.

d. The bulge and the disc of the milky way appear in other wavelengths of light:

1. In far infrared (heat waves, more than light), the disc of the milky way is prominent.

2. In the near infrared, the milky way looks more like it does in visible light.

A. You can also see the Magellanic clouds and Orion in this wavelength.

3. In long radio wavelengths like 21 cm (atomic hydrogen) and even gamma rays, you can still see the bulge and disc of the milky way.

4. X rays also show these features: the bright spots of x ray mostly hug the equator near the bulge of the milky way.

5. Wavelengths that detect molecules also show a molecular ring in the center of the milky way.

2. Features of the milky way:

- A. Major celestial objects like Orion, Sirius, Canopus, Vega, the Andromeda galaxy, the Pleiades, the southern cross, Cassiopea, Cygnus, the North American Nebula, and the Magellanic clouds can be seen around the milky way if you are in the corresponding hemisphere.
 - a. The southern cross is a group of stars in a cross shape. Two of the stars point to the south celestial pole, and two point to the south pole.
 - B. There is an enormous black area in the southern hemisphere milky way known as the "coal sack." This is dark material obscuring the stars of the milky way, not an absence of material.
 - a. There is a similarly dark area called the "great rift," though it is not so much a rift as a cloud of dark material in front of stars.
 - b. There are other splotches of black throughout the milky way.
 - C. Toward the bulge of the milky way, there is some streaky dark areas that no one understands or talks about.
3. Astronomers cannot see the very center of the milky way galaxy because it is obscured by lots of dark and bright material.
- A. You can find where the center is located using the constellation Sagittarius, which resembles a tea pot: the center is in a bright cloud of the milky way that resembles a puff of steam from Sagittarius' spout.
 - B. The milky way is so crowded, especially near the bulge, that is difficult to see very far through it.
 - C. Areas above and below the bulge, are less densely populated, so astronomers can see farther in those directions.
 - a. As astronomers approach the bulge, they see more of a haze of stars.
 - D. If astronomers look directly through the disc of the milky way in visible light, all they see is relatively close black material in the disc and blue giant stars in the foreground.
4. The areas in the milky way have different colors (black, blue, yellow, red) and densities that result from different kinds of areas in our galaxy.
- A. For example, there is a huge progression of the density of stars in the milky way, with the most dense areas being closest to the center.
 - B. The red areas below the main bulge in the milky way come from the same phenomena that makes sunsets red.
 - a. The stars in the bulge are many colors, but gas in the disk scatters blue light, so mostly red light reaches the earth.
 - C. There is a fairly clear area of space between the earth and the outer edge of the next spiral arm inward from us. It is possible to see blue stars and hydrogen pink nebulae about 8,000 lightyears away in the other arm.
 - a. There is also a bunch of dark stuff with ragged edges in the arm which is

where new stars are forming.

- D. Baade's window is an area where there is basically no material obscuring Earth's view of the bulge of the milky way.
- a. It is the brightest area of the milky way to earth, and the only place for astronomers to get visible light information about the center of the galaxy.
 - b. it was especially critical in the 50s and 60s before astronomers could look at the milky way in other wavelengths like radio and infrared.
 - c. There are red giants and blue giants in this area (plus other stuff).
 - d. Baade's biography:
 1. He was a german scientist who came to America in the 1930s to escape Nazism.
 2. His citizenship was questionable during the time of the war: He could not join other scientists in the war effort, but he could not be deported to axis Germany.
 - A. As a result, he had the 100 inch telescope at Mount Wilson observatory almost to himself.
 - a. Black outs in the cities around Mount Wilson on the coast made ideal conditions for studying faint galaxies.
 3. In this time, he created two different categories of galaxy:
 - A. Population 1 galaxies have new and old stars, plus gas and dust.
 - B. Population 2 galaxies have old stars, and only a smidgen of gas and dust.
 - C. Galaxies like the milky way are a mixture of population 1 and population 2 areas:
 - a. Population 1 areas are mostly in the disc of galaxies like the milky way.
 1. Because of this disc, the milky way is considered a population 1 galaxy.
 - b. Population 2 areas are almost all in the bulge and globular clusters.
5. The general layout of the milky way:
- A. There is a nucleus with a bulge around it.
 - a. The center of the milky way is about 28,000 light years from earth
 - B. There is a disc around the bulge.
 - C. There is a thin halo of hot gas around the whole disc and bulge with scattered globular clusters throughout.
 - a. The globular clusters contain old stars which were among the first stars born after the milky way galaxy formed 10 billion years ago.