The Milky Way

“Milky Way”: A band of light and a Galaxy

- The band of light we see is really 100 billion stars
- Milky Way probably looks like Andromeda.

Milky Way Composite Photo

- Bulge in the center
- Dark strip in the middle, from dust

Milky Way

Before the 1920's, astronomers used a “grindstone model” for the galaxy

- Tried to estimate our location in the galaxy by counting stars in different directions
- Because some stars are blocked by dust, the true shape of this group of stars was unclear.

Finding the Center

- Harlow Shapely studied globular clusters.
- He theorized that they must orbit the true center of the galaxy
Finding the Center
Shapely plotted the locations of the globular star clusters. He found that they are not centered on the Sun... but are centered on a point about 25,000 light years from the Solar System.

Parts of Our Galaxy

Disk: The Sun Resides in the Disk
Nuclear Bulge: The dense central region
Halo: Spherical region surrounding the disk where the globular clusters live.

Questions:
• How big is the Milky Way?
• Where are stars forming (or not forming)?
• How much mass is in the Milky Way?

Milky Way Scales Lecture Tutorial: Page 135-137
• Work with a partner or two
• Read directions and answer all questions carefully. Take time to understand it now!
• Discuss each question and come to a consensus answer you all agree on before moving on to the next question.
• If you get stuck, ask another group for help.
• If you get really stuck, raise your hand and I will come around.

Mapping the Milky Way

A modern map of the Milky Way (computer-generated diagram)
Measuring Distances

• To map the Milky Way Galaxy, we need to measure distances to stars.
• Parallax only works for nearby stars (within about 1000 light years)
• For more distant stars, we use Standard Candles

Standard Candles

Car Headlights are standard candles:
We use them to determine the car’s distance

Cepheid Variables

• In 1908, astronomer Henrietta Leavitt discovered a new standard candle using variable stars
• These stars are called Cepheids, named after δ Cephei
• These variable stars blink at different rates according to their luminosity (brighter = slower)

Henrietta Leavitt

Delta Cephei

Period-Luminosity Relation

• The connection between a Cepheid’s pulse period and its luminosity.
This relation can be used to determine the absolute magnitude of a Cepheid
Then, compare to the apparent magnitude and find the star’s distance.

Milky Way: A Spiral Galaxy

• Our galaxy seems to be rotating: it has spiral arms
• These are dense concentrations of stars and gas.
• Stars orbit the galactic center, pass through the spiral arms as they go.
• Stars slow down and pile up in the spiral arms, like cars in a traffic jam.

Star Formation in Spiral Arms

• Spiral arms contain gas and dust.
• Stars form out of nebulae in the spiral arms
• The spiral arms are denser than the rest of the disk
Star Formation in the Milky Way

The Disk contains gas, so stars are still forming there. (Population I stars)

The Halo has very little gas, and no new stars are forming there.

The halo of the galaxy is populated by old stars. (Population II stars)

Stellar Populations

- Pop. I: Newer, disk & spiral arm stars, with higher percentage heavy elements
- Pop. II: Older, bulge and halo stars, with lower percentage of heavy elements
- Heavy elements (metals): anything that isn’t H, He, or Li

The Center of the Milky Way

- The density of stars in the Galactic Center is much greater than in the Sun’s neighborhood.
- They appear to be orbiting a supermassive black hole at the center of the galaxy

Its mass is about 4 Million M$_{\odot}$!