

Classnotes 17

Our Galaxy

The 3 Major Components of the Galaxy:

Disk, Halo, and Nucleus. You should be able to identify these, to provide size estimates (mass, and linear sizes) and to identify typical constituents (i.e., globular clusters belong to the halo).

The Disk (Milky Way):

Why does the Milky Way appear as a thin ribbon across the sky? How did Herschel and later Kapteyn show that we were about centrally located in a thin disk of stars? Why did the later discovery of interstellar dust require a drastic revision of the Kapteyn universe? How did Shapley derive our position from mapping the globular clusters in the Halo? What is our position?

Interstellar Dust:

What is a Dark cloud? What is a Reflection Nebula? What is the spectrum of a reflection nebula? Why do most reflection nebulae appear blue in color photography? What is the Zone of Avoidance? Why do interstellar dust grains. The dust grains are formed in and expelled from the outer atmosphere of cool stars. You should be able to describe a typical dust grain: a silicate or graphite core, 1000 Å in diameter, a thin ice layer in cool clouds and absorbed atoms and molecules.

Interstellar Gas:

What is an emission (H II region) nebula? Explain how the uv photons from embedded stars ionize the hydrogen gas and Balmer (and other) hydrogen emission lines are produced. Describe how interstellar absorption lines are produced as starlight traverses a diffuse cloud. What is the 21 cm radio line of hydrogen? How is this line excited in interstellar gas clouds? Sketch the importance of this line to studies of the interstellar gas. Why are molecules found preferentially in dense clouds? How are the molecular radio lines excited? Name three recently discovered molecules.

The Galactic Halo:

Provide a description including the following: size, age of halo stars, composition of the stars, orbits of the stars (why are they referred to as high velocity stars?), properties of a globular cluster.

The Galactic Disk:

Provide a description including size (radius and thickness), spiral structure, properties of the typical galactic cluster, stellar ages (youngest stars in spiral arms, oldest spread throughout the disk), the rotation of the disk (Sun's speed, sketch of the rotation curve), mass of disk, number of stars in the Galaxy, fraction of gas to stars, fraction of dust to gas. Evidence for dark matter.

The Galactic Nucleus:

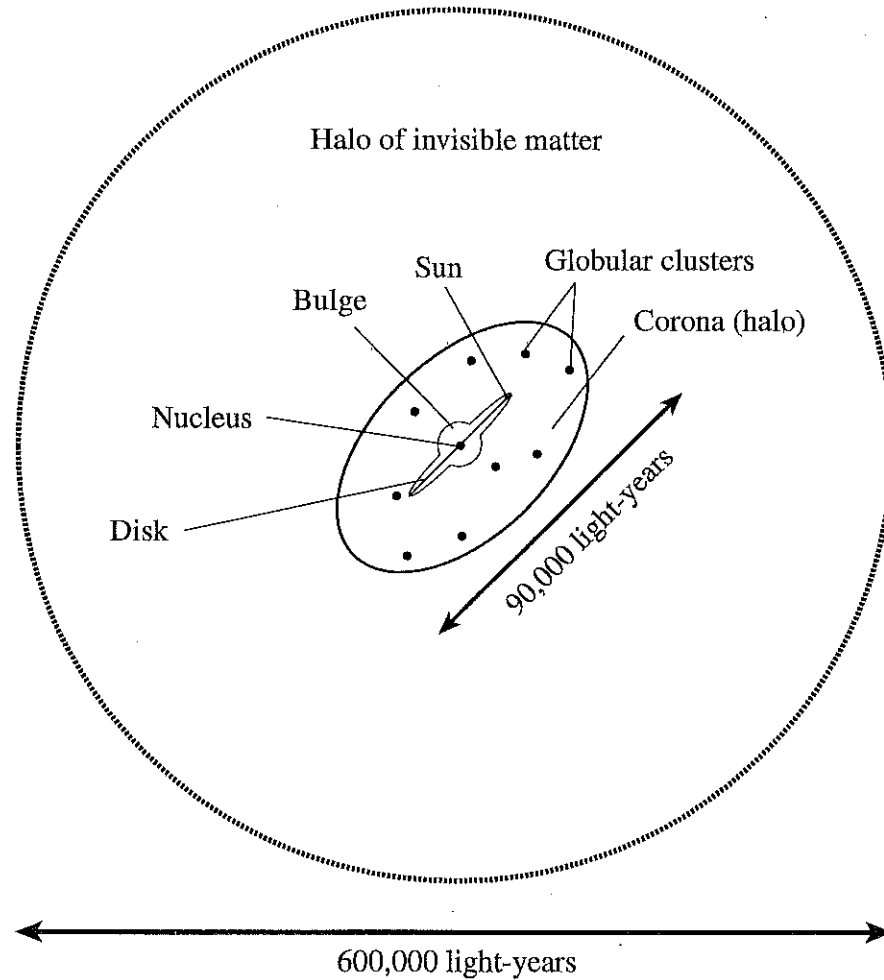
Is there a massive black hole?

Stellar Populations and the Formation of the Galaxy:

Describe how Baade through observations of the nucleus (and spiral arms) of the Andromeda Galaxy was led to the concept of Population I and II. Contrast Pop. I and II with respect to location in the Galaxy, motions, chemical composition and age. You should be able to describe the properties of Pop. I and II and show how they are consistent with the idea that the galaxy formed from a large and very slowly rotating gas cloud which was collapsing under its own gravitation.

Exercises

1. Describe a view of the sky near the center of a globular cluster.
2. If you saw the galaxy from a great distance, which should be brightest – open (= galactic) or globular clusters? Which reddest? Which farthest from the galactic disk?
3. Suppose the mean mass of a star in the Galaxy were only 1/3 solar mass. Using the value for the mass of the Galaxy found in the text, find how many stars the system contains. What did you assume about the total mass of interstellar matter in finding your answer?
4. Why does our position in the Milky Way make it difficult for us to see the overall structure of our Galaxy? How do we deduce the structure nevertheless?
5. How is a line like the hydrogen line Balmer b produced in an emission nebula?
6. Explain how at visual wavelengths a nebula can be brighter than the star which causes it to shine.



Something dark around galaxies. Studies of the motions of stars and gas in spiral galaxies show that the latter are surrounded by enormous invisible halos, five to ten times as large and massive as the visible part. This invisible matter appears to be present everywhere in the universe, but its true nature remains a mystery.