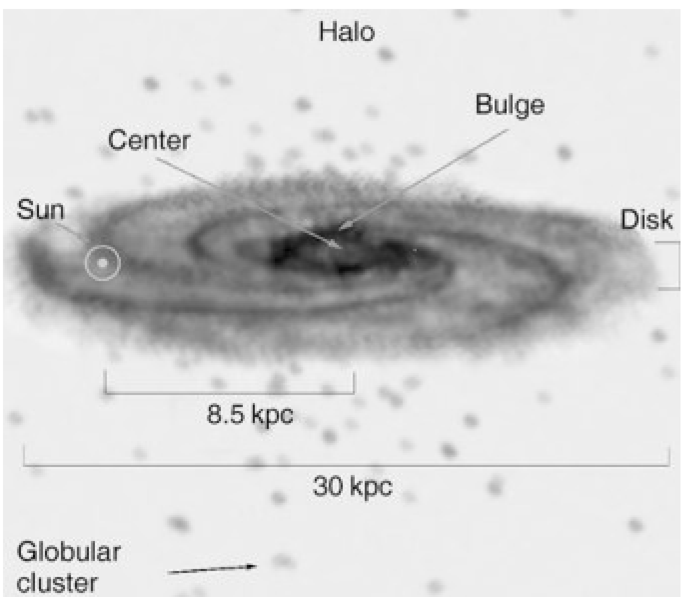
XIX B. Our Galactic Home - The Milky Way

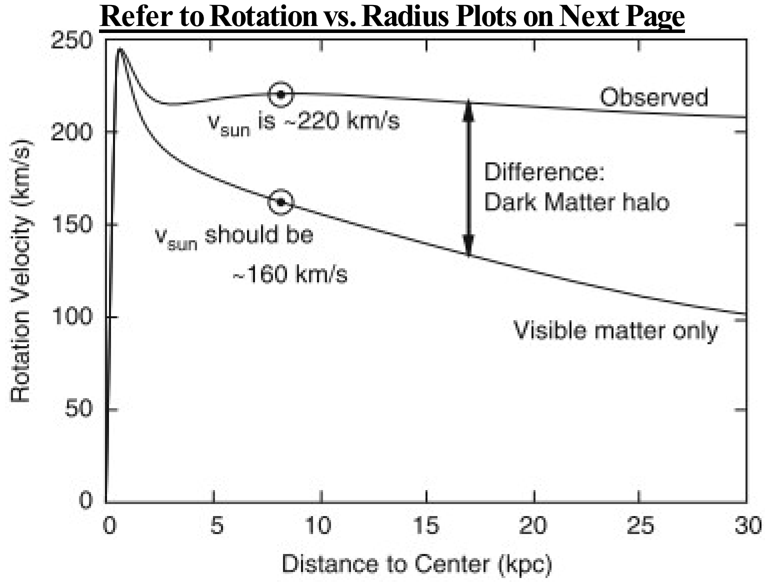
The Milky Way is a spiral galaxy that contains our solar system and is made up of billions of stars, gas, and dust. It's estimated to be about 100,000 light years in diameter. At its core it has a Super Massive Black Hole: **Sagittarius A*** (Sgr A*, pronounced "Sagittarius A-Star"). It is the only galaxy which we are able to examine in great detail. We can resolve individual stars and analyze them spectroscopically. We can perform detailed studies of the interstellar medium (ISM), such as the properties of molecular clouds and star forming regions. We can quantitatively examine extinction and reddening by dust. Furthermore, we can observe the local dynamics of stars and gas clouds as well as the properties of satellite galaxies (such the Magellanic Clouds).
Finally, **VLBI** Paralax reveals that the Galactic center is at a distance of **only 26,000 light years.** This gives us the unique opportunity to examine the central region of a galaxy at very high resolution. Only through a detailed understanding of our own Galaxy can we hope to understand the properties of other galaxies. Of course, we implicitly assume that the physical processes taking place in other galaxies obey the same laws of physics that apply to us. If this were not the case, we would barely have a chance to understand the physics of other objects in the Universe, let alone the Universe as a whole.

It is found that the Galaxy consists of several distinct components:
- a thin disk of stars and gas with a radius of about 20 kpc and a scale height of about 300 pc, which also hosts the Sun;
- a ≈ 1 kpc thick disk, which contains a different, older stellar population compared to the thin disk;
- a central bulge, as is also found in other spiral galaxies;
- and a nearly spherical Halo which contains most of the globular clusters, some old stars, and gas with different densities and temperatures. The Figure below shows a schematic view of our Milky Way and its various components.

Schematic View of Milky Way Galaxy



Refer to Rotation vs. Radius Plots on Next Page



Schematic Structure of the Milky Way consisting of the disk, the central bulge with the Galactic center, and the spherical halo in which most of the globular clusters are located. The Sun orbits around the Galactic center at a distance of 8.5 kpc with orbital velocity of 220 km/s.

The observed rotational velocity V_0 of the Sun around the Galactic center is significantly higher than would be expected from the observed mass distribution. If $M(R_0)$ is the mass inside a sphere around the Galactic center with radius R_0 = 8.5 kpc, then V_0 from Newtonian Mechanics is:

$$V_0 = \sqrt{\frac{G\,M(R_0)}{R_0}} .$$

The upper curve is the observed rotation curve $V(R)$ of our Galaxy, i.e., the rotational velocity of stars and gas around the Galactic center as a function of their galacto-centric distance. The lower curve is the rotation curve that we would predict based solely on the observed stellar mass of the Galaxy. The difference between these two curves is ascribed to the presence of dark matter, in which the Milky Way disk is embedded.

From the visible matter in stars we would expect a rotational velocity of 160 km/s, but we observe V_0 = 220 km/s. This indicates that the galaxy contains significantly more mass than is visible in the form of stars.