8.3 The Milky Way and Other Galaxies

Stars reside mostly in galaxies. There may be anywhere between 10^7 and 10^{11} stars in a galaxy. Milky Way is a spiral galaxy containing about 300 billion stars. A schematic view of the Milky Way, often referred to as the Galaxy (with the capital G), is shown in Fig. 8.4. It contains a disk with a central bulge filled with stars and containing a massive black hole at the center. Stars cluster spread out in the space above and below the disk of Milky Way. The disk itself has a spiral structure.

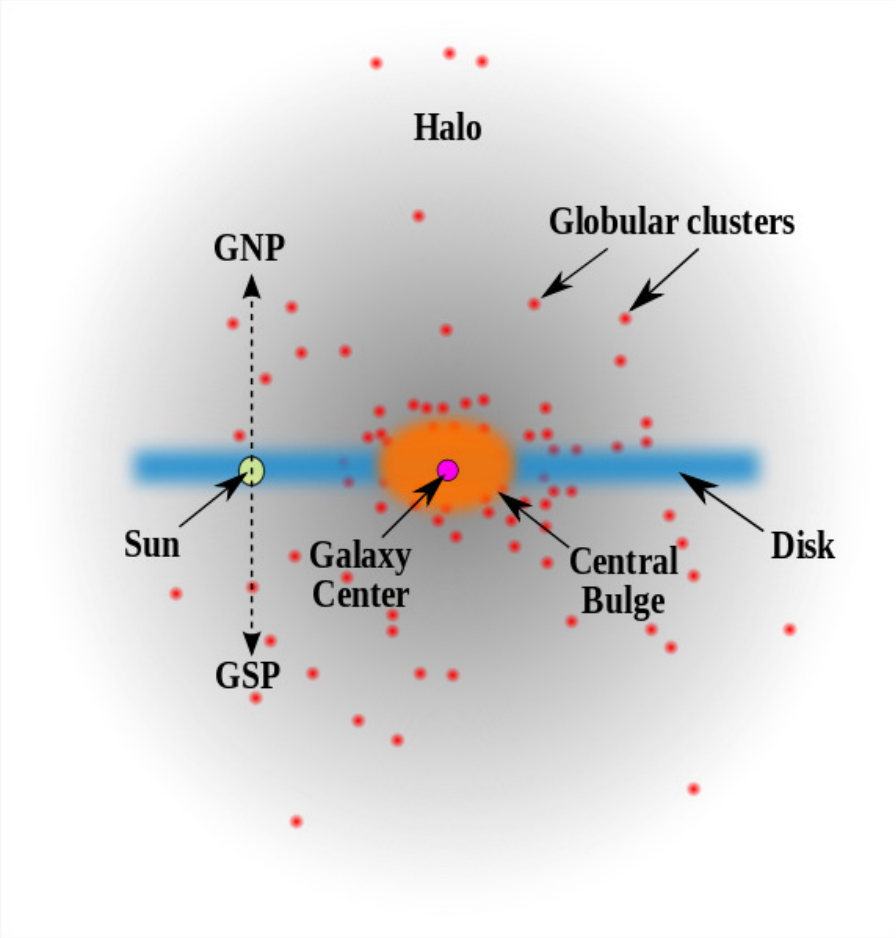

Figure 8.4: Schematic view of the Milky Way. GNP/GSP = direction of galactic north/south pole. Credits: Creative Commons.

Our Galaxy appears as a diffuse band in the night sky. The Sun is in the disk of the Milky Way, about half-way towards the edge. The distance of the Sun to the center is about 8 kpc. The Sun is moving in an orbit around the center of the Galaxy with the orbitalspeed of about 220 km/s. With the orbital radius of 8 kpc, and speed 220 km/s, we can calculate the orbital period of the Sun to be

$$T = \frac{2\pi r}{v} = 2 \times 10^8 \text{ y}.$$

The study of motion of stars at the edge and outside of the Galaxy has shown that the estimate of mass of the Galaxy based on the luminous matter cannot provide

the acceleration of these objects. There appears to be a dark halo, consisting of unspecified dark matter, surrounding the Galaxy.

In addition to spiral galaxies, these also exist elliptical galaxies and irregular galaxies. Spiral galaxies are more like the disk part and contain older stars. The irregular galaxies do not have defined shapes and are the most common types of galaxies. Surveys of galaxies have found that galaxies tend to form clusters with large voids in space.

Milky Way is part of a cluster of galaxies called the **Local Group** which extend to approximately 10 Mpc, which has around 40 galaxies. They include the Magellanic Clouds, Andromeda, and Triangulum galaxies. Hubble claimed that the Local Group may be an isolated structure in the general field. Others clusters of galaxies have also been observed. The universe also contains large voids which appear to be empty space or only sparsely filled with dust.

Active Galactic Nuclei

Galaxies appear to have black holes at the center. Some of these black holes are very active and acrete gas and other matter from its neighboring space. These nuclei are called Active Galactic Nuclei (AGN). The spectrum of light from AGNs show that they contain very hot gases. The studies by radio telescopes have shosn that they eject narrow beams of higly energetic electrons and produce synchrotron radiation. Some of the radio sources, which were originally thought to be from stars have turned out to be from sources are that are too bright to be single stars and are most certainly galactic centers; the luminosity of some can be as high as $10^{12}L_{\odot}$, where $L_{\odot}$ is the luminosity of Sun. These objects are very far away and are called quasars or quasi-stellar objects.