Chapter 27. Formation and Evolution of the Galaxy

Figure 27.1. A spiral galaxy similar to the Milky Way.

Note. In this section we consider the physical processes that lead to the current structure of the Milky Way galaxy.

Note. There are two types of stars:

Population I stars are relatively young. They are found in the disk and spiral arms of the galaxy. A primary feature is the presence of metals and heavier elements.

Population II stars are older. They are located in the halo and central bulge of the galaxy. They lack the presence of metals and heavier elements.

Note. Most of the stars in the Sun's neighborhood are Population I (including the Sun). There are Population II stars near, however. But most are *high-velocity stars* that are just passing though the galactic plan.

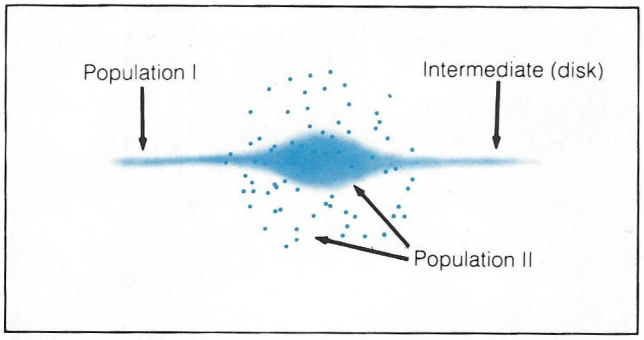

Figure 27.2. The distribution of Population I and II.

Note. As stars are born, live, and die, they "cook" heavy elements; in particular in supernova explosions. Interstellar material is cycled through stars and enriched with heavy elements. The reason there are the two populations of stars is that the older stars were formed when there was a lack of heavy elements. The younger stars (and those near the nucleus of the galaxy) formed when and where there was a presence of heavy elements.

Note. The spiral arms of the galaxy rotate in a rigid manner. This is explained by the *density wave theory*. A spiral shape (compressional) wave pattern centered at the galactic nucleus crates a "pinwheel" shape of alternating dense and empty regions (see Figure 27.6). The density waves concentrate the gas and dust accelerating star formation in the dust accelerating star formation in the spiral arms. The brightest stars live and die while still in the spiral arm. More long-lived stars may

wander from the spiral arms, however. The Sun (coincidentally) is presently in a spiral arm. The cause of the density wave is suspected to be an outside disturbance, possibly from the satellite Magellanic clouds.

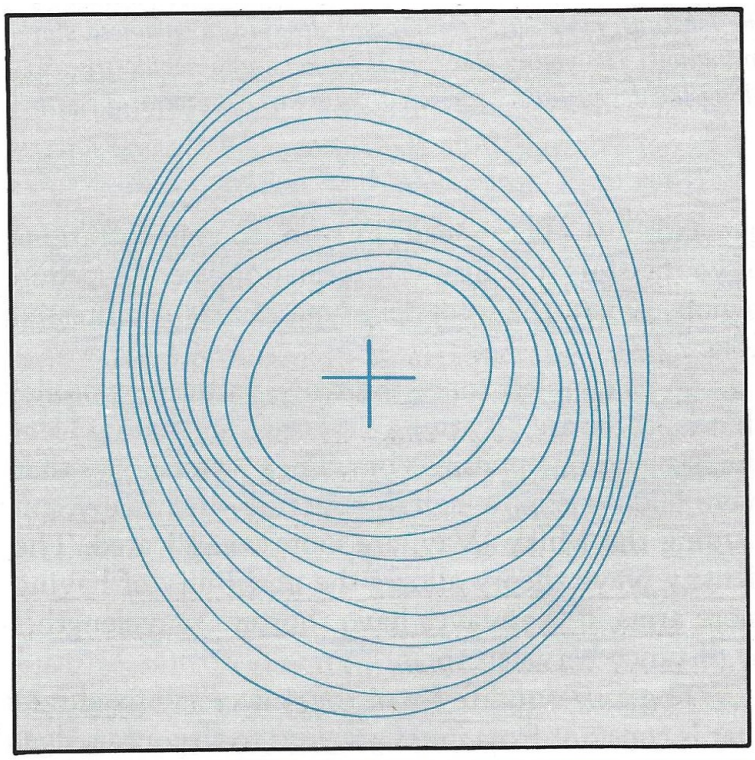

Figure 27.6. The density wave theory.

Note. Now for the origin of the Milky Way galaxy. The main sequence turnoff for globular clusters indicate an age of about 15 billion years, probably the age of the Galaxy itself. These and other old objects are distributed in the spherical halo, indicating that the Milky Way was initially a large spherical cloud of gas. The halo objects formed first, explaining the orbital trajectories of the Population II stars. As the cloud rotated it formed a disk.

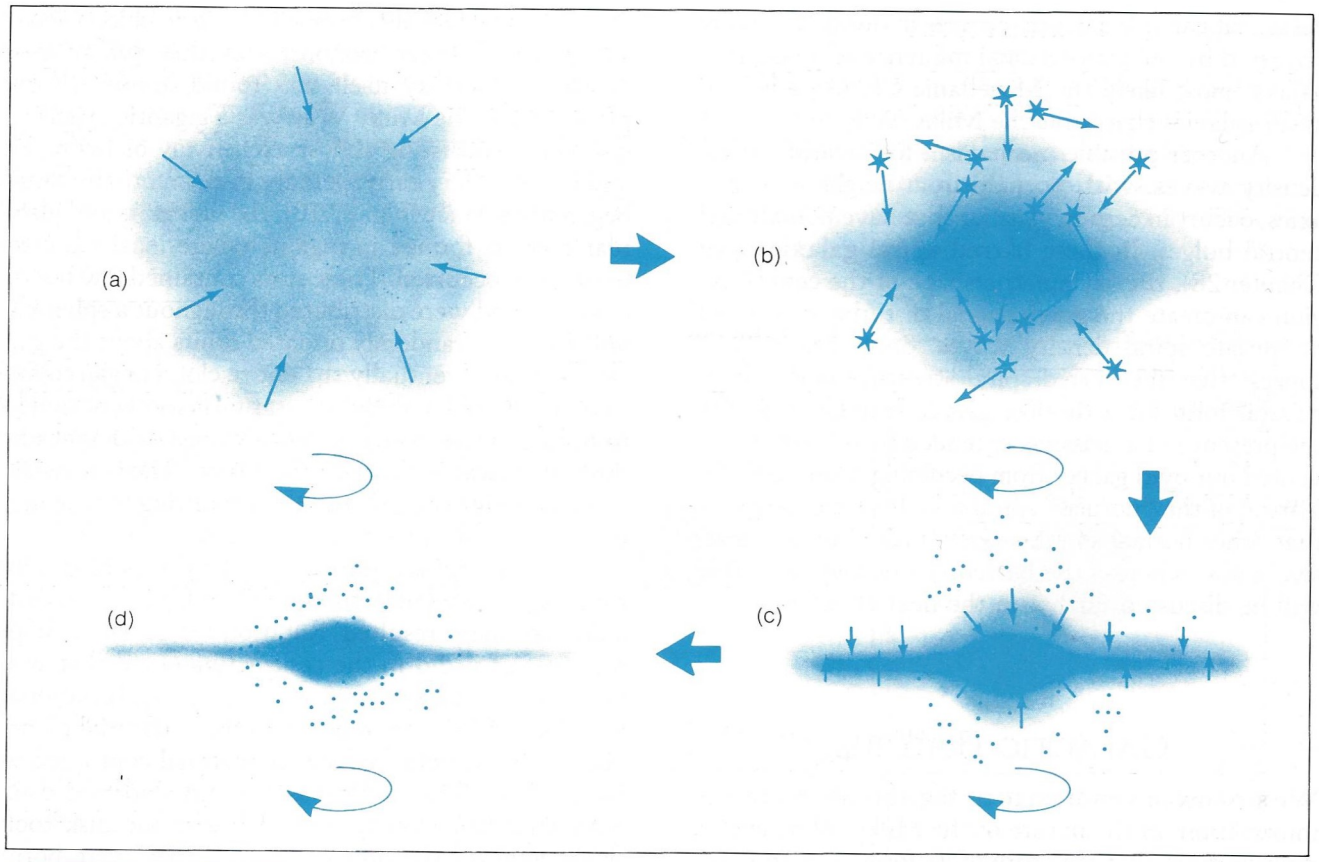

Figure 27.10. Formation of the Milky Way galaxy.

Note. The abundance of heavy elements indicates that there was a time of intense star formation. At this point, the amount of heavy elements jumped from almost zero to near its present size. The Milky Way would have been called a *starburst galaxy*.

Note. There are few disk shaped galaxies without a spiral structure, indicating that there must be something a bit unstable for the "armless" disk.

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