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ASTRONOMY

Chapter 25 THE MILKY WAY GALAXY

PowerPoint Image Slideshow

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25.1 THE ARCHITECTURE OF THE GALAXY

The Milky Way Galaxy appears in our sky as a faint band of light.

Dusty gas clouds obscure our view because they absorb visible light.

This is the ***interstellar medium*** that makes new star systems.

Figure 25.1

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- **Milky Way Galaxy.** The Milky Way rises over Square Tower, an ancestral pueblo building at Hovenweep National Monument in Utah. Many stars and dark clouds of dust combine to make a spectacular celestial sight of our home Galaxy. The location has been designated an International Dark Sky Park by the International Dark Sky Association.

Figure 25.2

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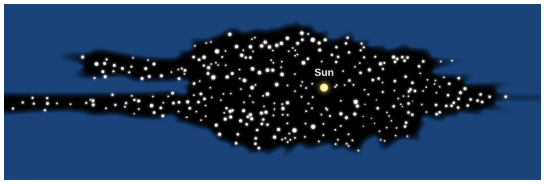
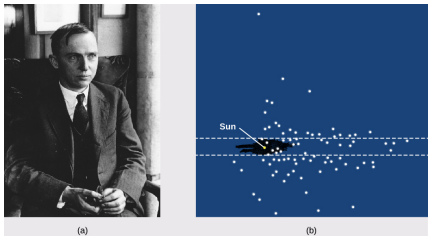
- **William Herschel (1738–1822) and Caroline Herschel (1750–1848).** William Herschel was a German musician who emigrated to England and took up astronomy in his spare time. He discovered the planet Uranus, built several large telescopes, and made measurements of the Sun's place in the Galaxy, the Sun's motion through space, and the comparative brightnesses of stars. This painting shows William and his sister Caroline polishing a telescope lens. (credit: modification of work by the Wellcome Library)

Figure 25.3



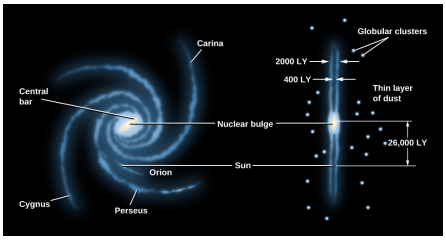
- **Herschel's Diagram of the Milky Way.** Herschel constructed this cross section of the Galaxy by counting stars in various directions.

Figure 25.4

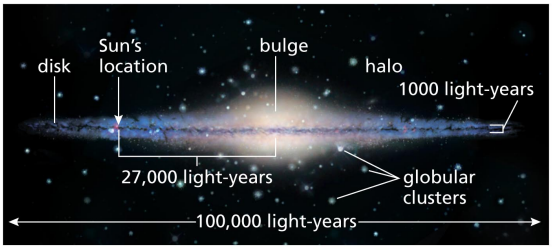


- **Harlow Shapley and His Diagram of the Milky Way.**
  - (a) Shapley poses for a formal portrait.
  - (b) His diagram shows the location of globular clusters, with the position of the Sun also marked. The black area shows Herschel's old diagram, centered on the Sun, approximately to scale.

Figure 25.5



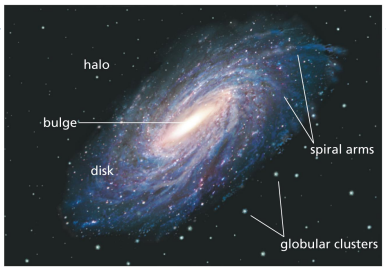
- **Schematic Representation of the Galaxy.** The left image shows the face-on view of the spiral disk; the right image shows the view looking edge-on along the disk. The major spiral arms are labeled. The Sun is located on the inside edge of the short Orion spur.



b Edge-on schematic view of the Milky Way.

We see our galaxy edge-on.

Primary features: disk, bulge, halo, globular clusters

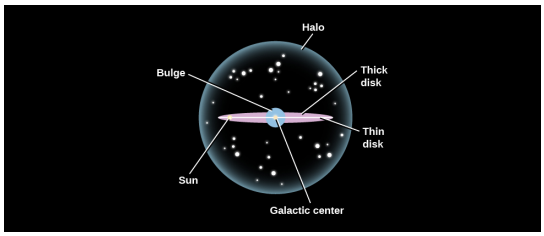


a Artist's conception of the Milky Way viewed from the outside.

MA INTERACTIVE FIGURE

If we could view the Milky Way from above the disk, we would see its spiral arms.

Figure 25.8

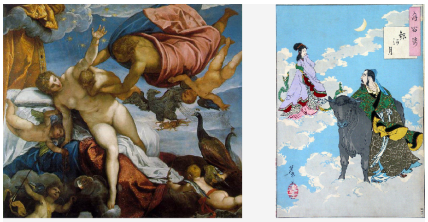


- **Major Parts of the Milky Way Galaxy.** This schematic shows the major components of our Galaxy.

Figure 25.7

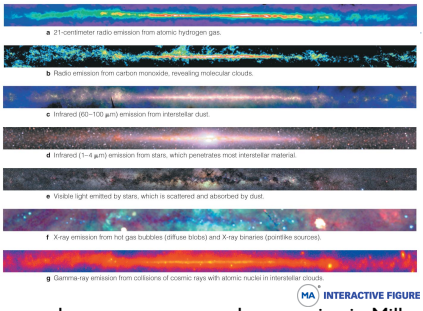
- **Inner Part of the Milky Way Galaxy.** This beautiful infrared map, showing half a billion stars, was obtained as part of the Two Micron All Sky Survey (2MASS). Because interstellar dust does not absorb infrared as strongly as visible light, this view reveals the previously hidden bulge of old stars that surrounds the center of our Galaxy, along with the Galaxy's thin disk component. (credit: modification of work by 2MASS/J. Carpenter, T. H. Jarrett, and R. Hurt)

Figure 25.9



(a) (b)

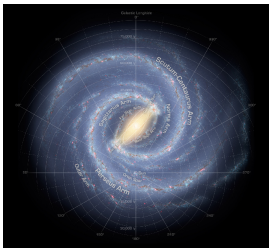
- **The Milky Way in Myth.**
  - (a) *Origin of the Milky Way* by Jacopo Tintoretto (circa 1575) illustrates the Greek myth that explains the formation of the Milky Way.
  - (b) *The Moon of the Milky Way* by Japanese painter Tsukioka Yoshitoshi depicts the Chinese legend of Zhi Nu and Niu Lang.



MA INTERACTIVE FIGURE

We observe the star–gas–star cycle operating in Milky Way's disk using many different wavelengths of light.

25.2 SPIRAL STRUCTURE



- **Milky Way Bar and Arms.** Here, we see the Milky Way Galaxy as it would look from above. This image, assembled from data from NASA's WISE mission, shows that the Milky Way Galaxy has a modest bar in its central regions. Two spiral arms, Scutum-Centaurus and Perseus, emerge from the ends of the bar and wrap around the bulge. The Sagittarius and Outer arms have fewer stars than the other two arms. (credit: modification of work by NASA/JPL-Caltech/R. Hurt (SSC/Caltech))

Figure 25.6

(a) (b)

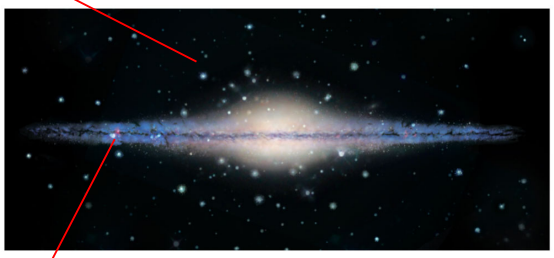
- **Unbarred and Barred Spiral Galaxies.**
  - (a) This image shows the unbarred spiral galaxy M74. It contains a small central bulge of mostly old yellow-red stars, along with spiral arms that are highlighted with the blue light from young hot stars.
  - (b) This image shows the strongly barred spiral galaxy NGC 1365. The bulge and the fainter bar both appear yellowish because the brightest stars in them are mostly old yellow and red giants. Two main spiral arms project from the ends of the bar. As in M74, these spiral arms are populated with blue stars and red patches of glowing gas—hallmarks of recent star formation.

Much of star formation in disk happens in spiral arms.

Ionization nebulae
Blue stars
Gas clouds

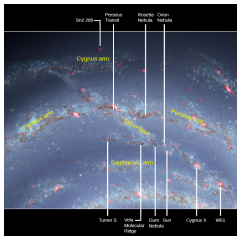
Spiral arms are waves of star formation.

Halo: No ionization nebulae, no blue stars
⇒ no star formation



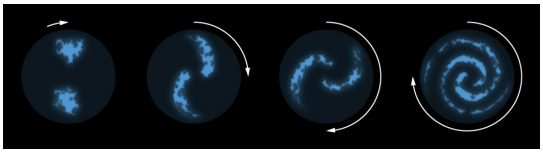
Disk: Ionization nebulae, blue stars ⇒ star formation

Figure 25.11



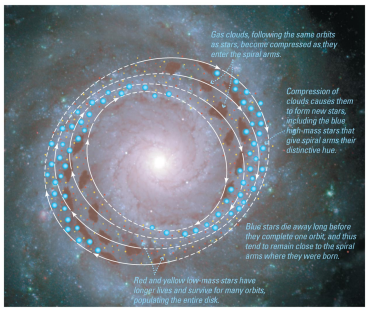
- **Orion Spur.** The Sun is located in the Orion Spur, which is a minor spiral arm located between two other arms. In this diagram, the white lines point to some other noteworthy objects that share this feature of the Milky Way Galaxy with the Sun. (credit: modification of work by NASA/JPL-Caltech)

Figure 25.12



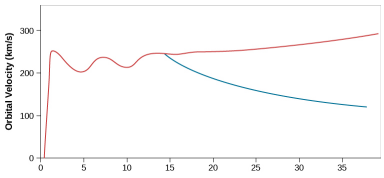
- **Simplified Model for the Formation of Spiral Arms.** This sketch shows how spiral arms might form from irregular clouds of interstellar material stretched out by the different rotation rates throughout the Galaxy. The regions farthest from the galactic center take longer to complete their orbits and thus lag behind the inner regions. If this were the only mechanism for creating spiral arms, then over time the spiral arms would completely wind up and disappear. Since many galaxies have spiral arms, they must be long-lived, and there must be other processes at work to maintain them.

Spiral arms are waves of star formation:

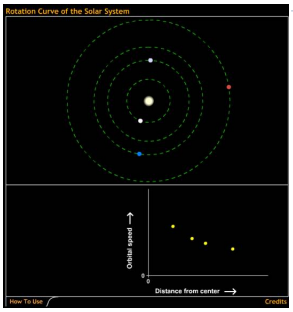


1. Gas clouds get squeezed as they move into spiral arms.
2. The squeezing of clouds triggers star formation.
3. Young stars flow out of spiral arms.

25.3 THE MASS OF THE GALAXY



- **Rotation Curve of the Galaxy.** The orbital speed of carbon monoxide (CO) and hydrogen (H) gas at different distances from the center of the Milky Way Galaxy is shown in red. The blue curve shows what the rotation curve would look like if all the matter in the Galaxy were located inside a radius of 30,000 light-years. Instead of going down, the speed of gas clouds farther out remains high, indicating a great deal of mass beyond the Sun's orbit. The horizontal axis shows the distance from the galactic center in kiloparsecs (where a kiloparsec equals 3,260 light-years).

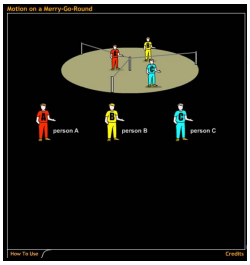


Rotation curve

A plot of orbital speed versus orbital radius

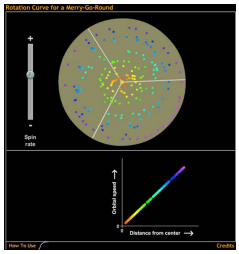
Solar system's rotation curve declines because Sun has almost all the mass.

PLAY Rotation Curve of the Solar System

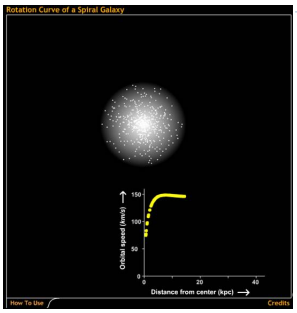


Who has the largest orbital speed?

A, B, or C?



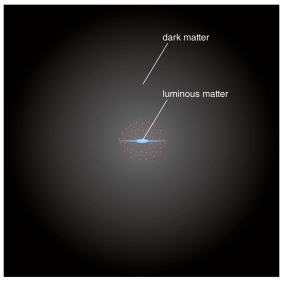
Motion on a Merry-Go-Round



The rotation curve of the Milky Way stays flat with distance.

Mass must be more spread out than in the solar system.

Rotation Curve of a Spiral Galaxy



The visible portion of a galaxy lies deep in the heart of a large halo of dark matter.