

## Section 28.1

### Objectives

- **Explain** how the solar system formed.
- **Describe** early concepts of the structure of the solar system.
- **Describe** how our current knowledge of the solar system developed.
- **Relate** gravity to the motions of the objects in the solar system.

### Review Vocabulary

**focus:** one of two fixed points used to define an ellipse

### New Vocabulary

planetesimal  
retrograde motion  
ellipse  
astronomical unit  
eccentricity

## Formation of the Solar System

**MAIN Idea** The solar system formed from the collapse of an interstellar cloud.

**Real-World Reading Link** If you have ever made a snowman by rolling a snowball over the ground, you have demonstrated how planets formed from tiny grains of matter.

### Formation Theory

Theories of the origin of the solar system rely on direct observations and data from probes. Scientific theories must explain observed facts, such as the shape of the solar system, differences among the planets, and the nature of the oldest planetary surfaces—asteroids, meteorites, and comets.

### A Collapsing Interstellar Cloud

Stars and planets form from interstellar clouds, which exist in space between the stars. These clouds consist mostly of hydrogen and helium gas with small amounts of other elements and dust. Dust makes interstellar clouds look dark because it blocks the light from stars within or behind the clouds. Often, starlight reflects off of the dust and partially illuminates the clouds. Also, stars can heat clouds, making them glow on their own. This is why interstellar clouds often appear as blotches of light and dark, as shown in **Figure 28.1**. This interstellar dust can be thought of as a kind of smog that contains elements formed in older stars, which expelled their matter long ago.

At first, the density of interstellar gas is low—much lower than the best vacuums created in laboratories. However, gravity slowly draws matter together until it is concentrated enough to form a star and possibly planets. Astronomers think that the solar system began this way. They have also observed planets around other stars, and hope that studying such planet systems will provide clues to how our solar system formed.


■ **Figure 28.1** Stars form in collapsing interstellar clouds, such as in the Eagle nebula, pictured here.





■ **Figure 28.2** The interstellar cloud that formed our solar system collapsed into a rotating disk of dust and gas. When concentrated matter in the center acquired enough mass, the Sun formed in the center and the remaining matter gradually condensed, forming the planets.

**Collapse accelerates** At first, the collapse of an interstellar cloud is slow, but it gradually accelerates and the cloud becomes much denser at its center. If rotating, the cloud spins faster as it contracts, for the same reason that ice skaters spin faster as they pull their arms close to their bodies—centripetal force. As the collapsing cloud spins, the rotation slows the collapse in the equatorial plane, and the cloud becomes flattened. Eventually, the cloud becomes a rotating disk with a dense concentration of matter at the center, as shown in **Figure 28.2**.

 **Reading Check** Explain why the rotating disk spins faster as it contracts.

**Matter condenses** Astronomers think our solar system began in this manner. The Sun formed when the dense concentration of gas and dust at the center of a rotating disk reached a temperature and pressure high enough to fuse hydrogen into helium. The rotating disk surrounding the young Sun became our solar system. Within this disk, the temperature varied greatly with location; the area closest to the dense center was still warm, while the outer edge of the disk was cold. This temperature gradient resulted in different elements and compounds condensing, depending on their distance from the Sun. This also affected the distribution of elements in the forming planets. The inner planets are richer in the higher melting point elements and the outer planets are composed mostly of the more volatile elements. That is why the outer planets and their moons consist mostly of gases and ices. Eventually, the condensation of materials into liquid and solid forms slowed.

## VOCABULARY

### ACADEMIC VOCABULARY

#### Collapse

to fall down, give way, or cave in

*The hot-air balloon collapsed when the fabric was torn.*



To read more about ways that astronomers are studying the formation of the solar system, go to the **National Geographic Expedition** on page 934.