

The Milky Way and Other Galaxies

KEY IDEAS

As you read this section, keep these questions in mind:

- What holds stars, gas, and dust together in galaxies?
- What are the different types of galaxies?
- How do scientists know that galaxies change over time?

What Are Galaxies?

You may know that scientists group planets and stars together into planetary systems. In a similar way, we can group large numbers of stars together into galaxies. A **galaxy** is a collection of millions or billions of stars, along with planets, gas, and dust between them. The deeper astronomers look into space, the more galaxies they see. In fact, scientists think that there may be more than 100 billion galaxies. ✓

Galaxies, such as the Andromeda galaxy in the figure below, contain many types of stars. Some of the stars in galaxies are very young. Remember that stars form from clouds of gas and dust called nebulae. The young stars in most galaxies are located in or near such nebulae.

Some of the stars in a galaxy may be much older than others. These older stars may be found anywhere in a galaxy. They may not be close to any nebulae.

Galaxies are much farther away from Earth than visible stars are. The nearest galaxies to Earth are millions of light-years away. In contrast, the nearest stars to Earth (other than our sun) are only a few light-years away.



The Andromeda galaxy is about 2.2 million light-years from Earth. This photo of the Andromeda galaxy was taken by a telescope. To the unaided eye, the Andromeda galaxy appears as a tiny, faint blur in a dark night sky.

READING TOOLBOX

Compare After you read this section, make a chart comparing the shapes of and types of stars found in each type of galaxy.

READING CHECK

1. **Define** What is a galaxy?

LOOKING CLOSER

2. **Explain** Why does the Andromeda galaxy appear so small, even though it contains billions of stars?

SECTION 2 The Milky Way and Other Galaxies *continued***What Holds Galaxies Together?**

Without gravity, all of space might contain just gas. Gravity causes clouds of gas and dust to come together and collapse to form stars. Gravity holds nearby stars close together to form a galaxy. As the first stars in a galaxy get older, they throw off gas and dust. As new stars form, gravity keeps them in the galaxy, along with the gas, dust, and old stars. ✓

You probably know that Earth orbits around our sun because of gravity. In a similar way, gravity causes our solar system to revolve around the center of our galaxy. The solar system takes about 226 million years to complete one orbit of the galaxy.

READING CHECK

3. Identify What force holds stars together in galaxies?

CLUSTERS OF GALAXIES

Galaxies are not scattered randomly throughout the universe. Gravity holds galaxies together in **clusters**, like the one in the figure below. The Milky Way galaxy belongs to a galaxy cluster called the Local Group. The Local Group also contains the Andromeda galaxy and about 30 other galaxies. Astronomers are still finding new members of the Local Group. ✓

READING CHECK

4. Identify What galaxy cluster contains the Milky Way and Andromeda galaxies?

LOOKING CLOSER

5. Make Connections What do you think is the reason this cluster of galaxies is called a quintet?



This small cluster of galaxies, known as Stephen's Quintet, is about 270 million light-years from Earth.

Clusters of galaxies form even larger groups called *superclusters*. A typical supercluster contains galaxy clusters that each consist of up to thousands of galaxies. A supercluster can contain trillions of stars. Superclusters are the largest known structures in the universe. They can be up to 100 million light-years across.

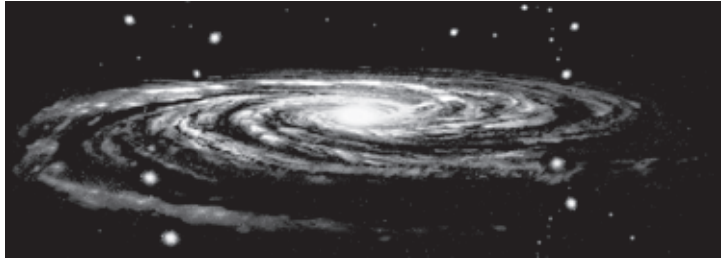
SECTION 2 The Milky Way and Other Galaxies *continued***How Many Types of Galaxies Are There?**

Astronomers divide galaxies into three main types based on their shape. These three types are spiral, elliptical, and irregular. *Spiral galaxies* have spiral arms of gas, dust, and stars. *Elliptical galaxies* contain little gas or dust and have round or oval shapes. *Irregular galaxies* do not have any particular shape. ✓

OUR OWN GALAXY

Our solar system is located in a spiral galaxy called the Milky Way galaxy. Our solar system lies in a spiral arm of our galaxy, about 26,000 light-years from the galaxy's center. We are about halfway between the galaxy's center and its edge.

Most of the objects you see in the night sky belong to the Milky Way galaxy. However, we cannot see all of our galaxy at once because our solar system is inside it. Therefore, scientists must use data from telescopes and other instruments to determine that the Milky Way is a spiral galaxy.



Based on astronomical observations, scientists think our galaxy is a spiral galaxy. This is an artist's idea of what our galaxy may look like.

Like most spiral galaxies, the Milky Way galaxy has a huge bulge in its center. The centers of spiral galaxies give off reddish light. Remember that cool stars give off mostly reddish light. The light from the centers of spiral galaxies suggests that they contain mostly old stars, such as red giants. ✓

The spaces between the stars in the arms of a spiral galaxy contain gas and dust called **interstellar matter**. Clouds of interstellar matter provide the materials to form new stars. In fact, the spiral arms of many galaxies give off blue light. Scientists think this light comes from many hot, young stars in the arms. Stars can form in the arms because there is so much interstellar matter there.

 **READING CHECK**

6. List What are the three types of galaxies?

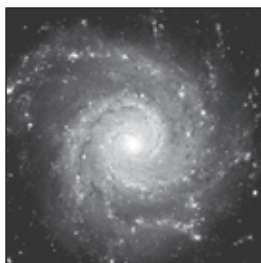
LOOKING CLOSER

7. Identify What type of galaxy is the Milky Way galaxy?

 **READING CHECK**

8. Explain What evidence indicates that the centers of spiral galaxies contain mostly old stars?

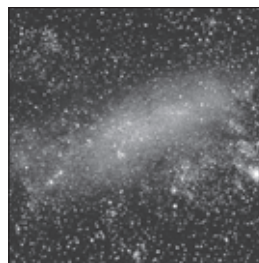
SECTION 2 The Milky Way and Other Galaxies *continued*



Messier 74 is an example of a spiral galaxy.



Messier 87 is an example of an elliptical galaxy.



The Large Magellanic Cloud is an example of an irregular galaxy.

LOOKING CLOSER

9. Identify What kind of galaxy is Messier 87?

Critical Thinking

10. Apply Concepts Suppose a scientist discovered a galaxy that had a bluish center. Do you think there would be interstellar dust in the center of the galaxy or not? Explain your answer.

ELLIPTICAL GALAXIES

Elliptical galaxies, such as Messier 87, shown above, have spherical or oval shapes and no spiral arms. Elliptical galaxies can be large or small. Giant elliptical galaxies contain trillions of stars and can have diameters up to 200,000 light-years. Dwarf elliptical galaxies contain only a few million stars and have much smaller diameters.

Most elliptical galaxies have a reddish color, which indicates that they contain mostly older stars. Astronomers think that elliptical galaxies contain very little interstellar matter.

IRREGULAR GALAXIES

American astronomer Edwin Hubble named the third type of galaxy irregular galaxies because they do not have regular shapes. The figure above shows the Large Magellanic Cloud. This irregular galaxy in the Local Group lies closer to our Milky Way than any other galaxy.

Irregular galaxies do not have any well-defined structures. Some irregular galaxies contain little interstellar matter. Others have large amounts of it and contain mostly young, hot, blue stars.

Like elliptical galaxies, irregular galaxies come in different sizes. Astronomers have seen many more dwarf irregular galaxies than giant irregulars. Some irregular galaxies have particularly odd shapes. The gravitational pull from nearby galaxies may distort them.

SECTION 2 The Milky Way and Other Galaxies *continued*

Do Galaxies Change Over Time?

When astronomers observe distant galaxies, they are actually looking back in time. For example, light we see today from a galaxy one billion light-years away left that galaxy one billion years ago. Therefore, when scientists study distant galaxies, they are actually seeing what the galaxies looked like in the past.

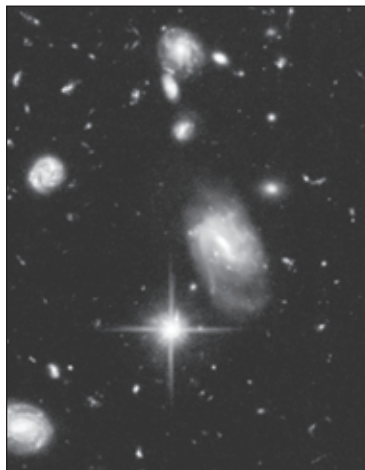
The more distant the galaxy, the further back in time we can see. Therefore, by studying similar galaxies at different distances, astronomers can study how galaxies change through time.

LISTENING TO FARAWAY GALAXIES

In 1960, astronomers matched a faint object they saw in optical telescopes with a strong radio signal. They called it a **quasar**, or *quasi-stellar object*, because it looked like a star. Further study showed that quasars are the most distant and most radiant objects in space. Scientists think quasars may be the central parts of very young galaxies.

Many distant galaxies give off blue light. That indicates that the galaxies contain young stars. Other galaxies give off red light. This indicates that they contain only older stars. They probably contain little interstellar matter, so stars cannot easily form there. ✓

The Hubble Deep Field project discovered many faint and very distant galaxies, such as those shown here.



Galaxies also change as a result of collisions. As galaxies approach each other, gravitational attraction alters their shapes. Individual stars rarely hit one another when the galaxies collide. However, collisions of gas and dust can produce bursts of new star formation.

Critical Thinking

11. Infer The Andromeda galaxy is 2.2 million light-years away. How long does it take light to travel from the Andromeda galaxy to Earth?

READING CHECK

12. Explain How is the color of light from a galaxy related to the types of stars that the galaxy contains?

Section 2 Review

SECTION VOCABULARY

<p>cluster a group of stars or galaxies bound by gravity</p> <p>galaxy a collection of stars, dust, and gas bound together by gravity</p> <p>interstellar matter the gas and dust located between the stars in a galaxy</p>	<p>quasar quasi-stellar radio source; a very luminous object that produces energy at a high rate; quasars are thought to be the most distant objects in the universe</p>
--	---

1. **Contrast** How are galaxies, clusters, and superclusters different?

2. **Compare** How are the centers of many spiral galaxies similar to many elliptical galaxies?

3. **Explain** How do astronomers know what the Milky Way galaxy looks like, if they can only see part of it?

4. **Explain** What do scientists think is the reason that irregular galaxies may not have consistent shapes?

5. **Identify** About how many galaxies do scientists think exist?

6. **Apply Concepts** A supercluster is 100 million light-years across. How long would it take light to travel from one edge of the supercluster to the center of the supercluster?

7. **Describe** Explain how the shapes of spiral, elliptical, and irregular galaxies are different.
