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CHAPTER 19 Stars, Galaxies, and the Universe

SECTION 3

Galaxies

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are different shapes that a galaxy can have?
- What are galaxies made of?
- How do galaxies form?

What Is a Galaxy?

If you look out on a clear night far from city lights, you can see hundreds of stars. Many of these stars are part of our galaxy, which is called the *Milky Way*. Our galaxy actually contains many more stars than you can see.

A **galaxy** is a large group of gas, dust, and millions of stars. The biggest galaxies contain more than a trillion stars. Scientists can't actually count the stars, of course. They estimate how many stars are in a galaxy by measuring the size and brightness of the galaxy. The bigger and brighter the galaxy, the more stars it has. ☑

Galaxies come in different shapes and sizes. Scientists classify galaxies by shape. The three most common types of galaxies are spiral, elliptical, and irregular.

STUDY TIP

Compare As you read, make a table comparing the three different types of galaxies.

READING CHECK

1. Explain How do scientists estimate how many stars a galaxy has?

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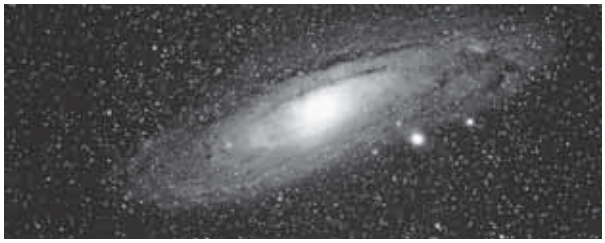
SPIRAL GALAXIES

A *spiral galaxy* has two parts: a central bulge and arms that form a spiral around the center. The bulge is a dense group of old stars. The arms are made of gas, dust, and much younger stars.

The Milky Way is a spiral galaxy. Our sun is one of the 200 billion stars in the Milky Way. From Earth, the edge of the Milky Way looks like a bright belt of stars that stretches across the night sky.



The Andromeda galaxy is a spiral galaxy. Our galaxy, the Milky Way, probably looks very much like Andromeda.

TAKE A LOOK

2. Identify Label the part of the galaxy that contains the oldest stars.

ELLIPTICAL GALAXIES

An *elliptical galaxy* is made of many stars and looks like a snowball. Elliptical galaxies are among the largest galaxies in the universe. Some may contain as many as 5 trillion stars! There is very little free gas in an elliptical galaxy. Therefore, few new stars form there.

TAKE A LOOK

3. Compare Name two ways that spiral galaxies differ from elliptical galaxies.

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Galaxy M87, an elliptical galaxy, has no spiral arms.

IRREGULAR GALAXIES

An *irregular galaxy* has no clear shape. It may have as few as 10 million or as many as several billion stars. Some irregular galaxies form when two other galaxies collide.

The Large Magellanic Cloud, an irregular galaxy, is close to our own.

READING CHECK

4. Identify What are galaxies made of?

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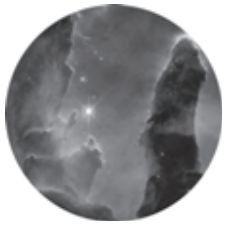
What Objects May Be Found in Galaxies?

Remember that galaxies are made of gas, dust, and billions of stars. Some of these stars form different features, such as nebulas, open clusters, and globular clusters. When scientists study the stars in galaxies, they look for these features. ☑

NEBULAS

A **nebula** (plural, *nebulae* or *nebulas*) is a large cloud of gas and dust. Most stars are born in nebulas. Some nebulas glow or reflect starlight, but others absorb light and are too dark to see. Therefore, although nebulas can be found throughout a galaxy, they can be hard to see. ☑



This is part of a nebula. The tall, thin shape to the left of the bright star is wider than our solar system.

READING CHECK

5. Explain Why are some nebulas hard to see?

_____

STAR CLUSTERS

An **open cluster** is a group of 100 to 1,000 stars. The stars in an open cluster are closer together than stars in other parts of space. Open clusters are usually found in the arms of a spiral galaxy. All of the stars in an open cluster are the same age. They formed at the same time from the same nebula. Newly formed open clusters have many bright blue stars.

A **globular cluster** is a group of up to 1 million stars that are packed closely together. A globular cluster looks like a ball. Some globular clusters orbit spiral galaxies, such as the Milky Way. Others can be found near giant elliptical galaxies.

Critical Thinking

6. Compare How is a nebula different from a star cluster?

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_____

What Are Quasars?

Remember that light from stars can take millions of years to reach Earth. Therefore, looking at distant stars is like looking back in time. Scientists study the early universe by studying objects that are very far away. Looking at distant galaxies shows what early galaxies looked like. By studying distant galaxies, scientists can learn how galaxies form and change.

Among the most distant objects are quasars. **Quasars** are starlike sources of light that are very far away. They are among the strongest energy sources in the universe. Some scientists think that quasars may be caused by black holes, but they are not sure how this happens.

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Section 3 Review

SECTION VOCABULARY

galaxy a collection of stars, dust, and gas bound together by gravity

globular cluster a tight group of stars that looks like a ball and contains up to 1 million stars

nebula a large cloud of gas and dust in interstellar space; a region in space where stars are born

open cluster a group of stars that are close together relative to surrounding stars

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

1. Compare How is a nebula different from a galaxy?

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2. List What three shapes can galaxies be?

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3. Compare Complete the chart below to describe different features of galaxies.

Galaxy feature	What they are made of	Where they are found	Other characteristics
		throughout a galaxy	where stars form
	100 to 1,000 stars, relatively close together		may contain bright blue stars
Globular cluster		around a spiral galaxy or near a large elliptical galaxy	

4. Explain What do some scientists think causes quasars?

_____

2. The x-axis should be labeled "Spectral type" or "Temperature"; the y-axis should be labeled "Absolute magnitude" or "Relative brightness."
3. From the main sequence to a red giant, the star becomes cooler. From a red giant to a white dwarf, the star becomes hotter.
4. After its main sequence, an average star becomes a red giant. After its main sequence, a massive star may become a neutron star, pulsar, or black hole.

SECTION 3 GALAXIES

1. They measure the size and brightness of the galaxy.
2. The bright bulge in the center should be labeled.
3. A spiral galaxy has arms, and an elliptical galaxy does not. Spiral galaxies have many new stars, and elliptical galaxies do not.
4. gas, dust, and stars
5. They absorb light.
6. Nebulas are where stars are born. Star clusters have stars that were born in nebulas.

Review

1. A nebula is a part of a galaxy. It is where stars form. A galaxy is a group of many stars, dust, and gas.
2. spiral, elliptical, irregular
3.

Galaxy feature	What they are made of	Where they are found	Other characteristics
Nebula	gas and dust	throughout a galaxy	is where stars form
Open cluster	100 to 1,000 stars, relatively close together	on the arms of a spiral galaxy	may contain bright blue stars
Globular cluster	up to 1 million stars, packed close together	around a spiral galaxy or near a large elliptical galaxy	looks like a ball

4. black holes

SECTION 4 FORMATION OF THE UNIVERSE

1. expanding
2. Temperature decreased.
3. They were squeezed into one very small volume.
4. expansion of the universe and cosmic background radiation
5. planets; each galaxy can contain many planets
6. Top to bottom: universe, galaxy cluster, galaxy, planetary system, planet
7. about 14 billion years

Review

1. If the universe is expanding, then the contents of the universe originally must have been crowded together in one small volume, from which the universe exploded and expanded.
2. Some scientists think that cosmic background radiation is energy left over from the big bang explosion.
3. the light elements, the forces of nature, the beginnings of galaxies
4. Planets make up planetary systems. Planetary systems make up galaxies. Galaxies make up galaxy clusters.
5. I would study the oldest stars in the Milky Way to find their age. Because it took 1 billion years for the first white dwarfs to form, the universe must be 1 billion years older than the oldest white dwarf.

Chapter 20 Formation of the Solar System

SECTION 1 A SOLAR SYSTEM IS BORN

1. gravity, pressure
2. It pulls them together.
3. It makes the nebula expand, or get bigger.
4. particles bumping into each other
5. small regions of a nebula that have been compressed
6. a small planet
7. Jupiter, Saturn, Uranus, Neptune

Review

1. It became the solar system.
2. gravity
3. Large planetesimals formed near the outside of the solar nebula. They attracted large amounts of gas. This gas and planetesimal material formed the gas giant planets.
4. Small planetesimals formed near the center of the solar nebula. They attracted dust and rock particles from the nebula. This material formed the inner, rocky planets.
5. at the center
6. Mercury, Venus, Earth, Mars