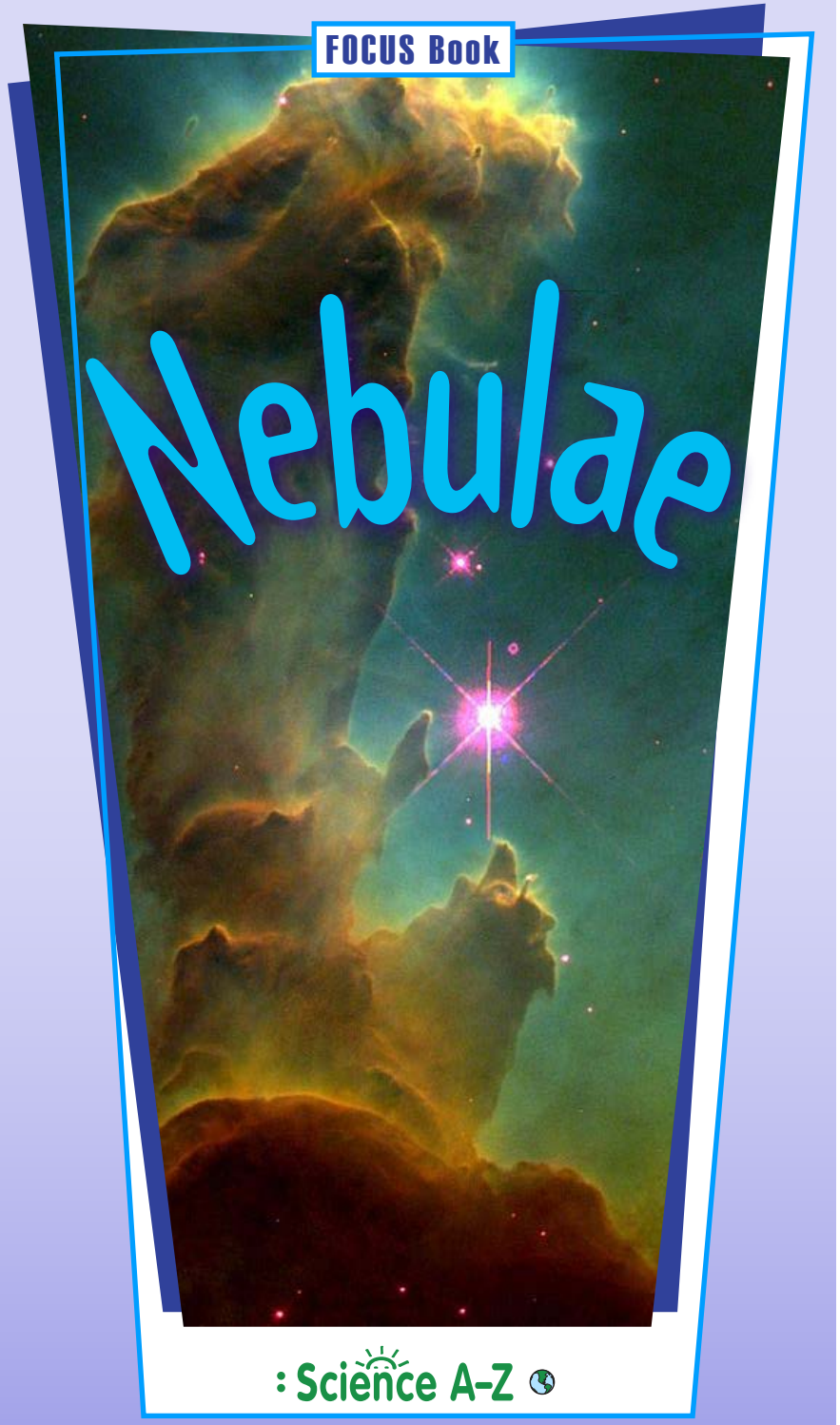
Be a Scientist!

You have learned that a nebula can turn into a star, and that the star can turn into a new nebula. Now design a comic, timeline, flowchart, or cycle diagram to explain this process. Include sentences or labels explaining how the nebula and star each change over time. Be sure to explain how gravity is important to those changes.

Beyond the Book

Use the Internet to find images of one nebula that were made using different telescopes (or different systems on the same telescope). What kind of information can we get from each type of image?



Nebulae

FOCUS Question

What is the relationship between nebulae and stars?

Scale, Proportion, and Quantity

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Nebulae
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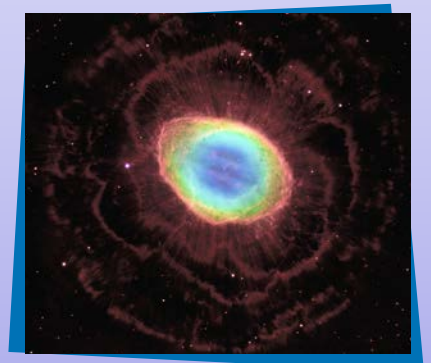
What Is a Nebula?

The universe is made of billions of *galaxies*—groups of thousands to trillions of stars held together by the force of gravity. Dust and gas are scattered in the space between the stars. A *nebula* forms when some of the dust and gas clumps together into a cloud-like formation.

Emission nebulae form around stars. The stars heat up the gas and dust so much that the nebulae give off their own light.

This emission nebula is known as the Rosette Nebula.

A *stellar remnant nebula* is a special type of emission nebula. Stellar remnant nebulae form when a dying star blows off layers of gas. The gas is so hot that it emits its own light. This type of nebula is also called a *planetary nebula* because it is shaped like a planet.



This stellar remnant nebula is called the Ring Nebula.

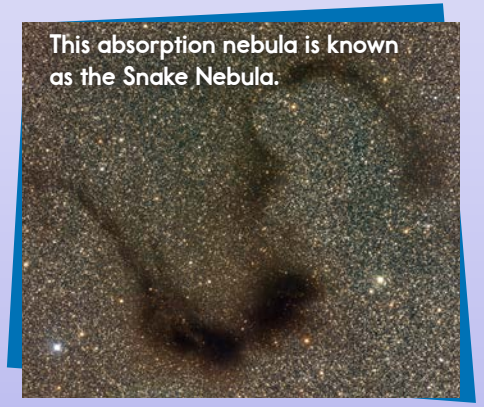
Word Wise

The plural form of nebula is *nebulae* (NEB-yoo-lee).

Reflection nebulae are cooler than emission nebulae and do not give off their own light. Instead, they reflect the light from nearby stars.


This reflection nebula is known as the Boomerang Nebula.

Unlike other types of nebulae, *absorption nebulae* do not look much like clouds. They neither emit nor reflect light. Instead, they absorb light. They appear as black regions in space.

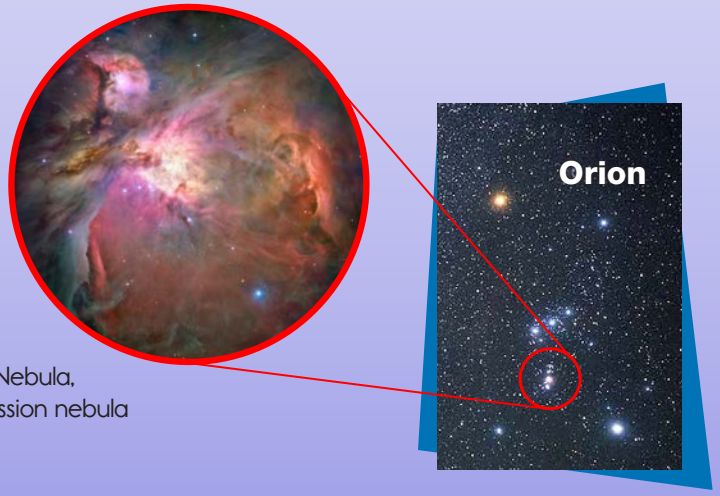

This absorption nebula is known as the Snake Nebula.

Nebulae are mostly made of the gases hydrogen and helium. About 90 percent of a nebula is hydrogen, and 9 percent is helium. There are smaller amounts of other elements such as oxygen, carbon, and nitrogen. In fact, nebulae have the same mix of elements as stars. Astronomers now know that nebulae are made of materials that came from ancient stars.

If you look into a clear, dark sky, you might be able to see some nebulae without a telescope. The Orion Nebula, for example, is visible in the constellation Orion. Most nebulae are hard to distinguish from stars, however. To learn much about them, we need telescopes.

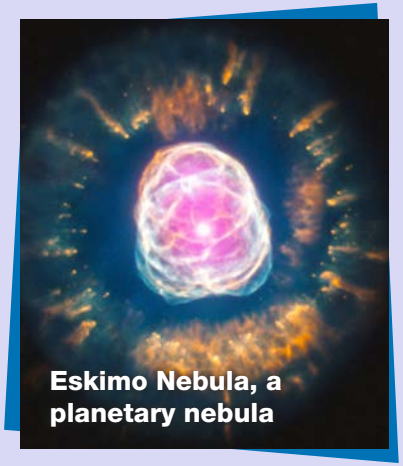
Some telescopes allow us to observe the visible light energy coming from nebulae. We can learn what nebulae are made of by observing their visible light, but nebulae also give off other types of energy that we cannot see. These forms of light energy include infrared, ultraviolet, X-rays, and gamma rays.

Studying different types of light that nebulae emit and reflect helps us understand them. The Hubble Space Telescope (HST), which has been orbiting Earth since 1990, has recorded infrared, visible light, and ultraviolet pictures from space. With the HST, we learned that dust and gas of the Orion Nebula is heated by thousands of stars.



Orion Nebula, an emission nebula

This image of the Eskimo Nebula was made using the Chandra X-Ray Observatory, a space telescope. The pink parts of this image are "false color." The light is not actually pink; it represents the light from X-rays. All of the other colors are the actual colors that we can see with our eyes.



Eskimo Nebula, a planetary nebula

The Spitzer Space Telescope observes infrared light. The colors in the image below represent different wavelengths of infrared light. The dark parts of the image are not giving off any infrared light. They are dense, cold, dark regions of sooty dust.

The dark, snakelike line at the top left is a giant cloud of dust.

Star Nurseries

When astronomers first began studying nebulae, all they could see were fuzzy regions in space. Today, using powerful telescopes, scientists can see nebulae more clearly. They have discovered that many nebulae are *star nurseries*—places where new stars are forming.

Word Wise

The word *nebula* comes from the Latin word for *mist* or *clouds*. The word *nebulous* comes from the same root. Something that is nebulous is very unclear or vague.

Because gravity pulls matter together, over time the gas and dust of a nebula begin to collapse. Clumps of material come together. The gravitational pull increases, and clumps of particles move faster. As the particles move faster and faster, they become hotter and hotter. When the clumps get big enough and have enough energy, they become hot, glowing stars.

Stars are forming inside the Horsehead Nebula, about 1,500 light-years from Earth.

How Nebulae Form

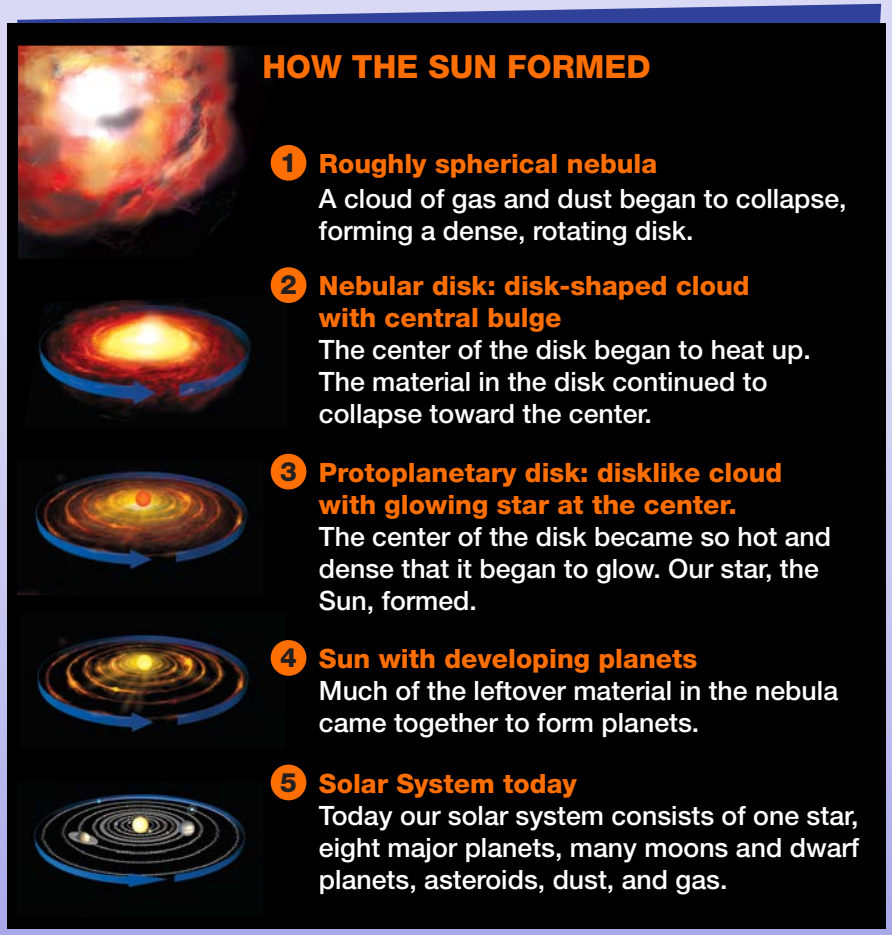
Not only do nebulae form stars, but they also *come from* stars. A small planetary nebula forms when an old, dying star blows off material from its outer shell. A large nebula can form as a result of a *supernova*—a bright, massive explosion of a large star.

Nearly 1,000 years ago, in the year 1054, people observed a new star in the sky. The star was so bright that people could see it during the daytime. But over the course of about two years, the star dimmed. Eventually, it was no longer visible. Hundreds of years later, astronomers using telescopes observed a nebula in the same part of the sky. They eventually realized that this nebula, called the Crab Nebula, was the result of the supernova observed in 1054.

The first drawings of the Crab Nebula, in 1844, looked like a crab. When it is observed through powerful modern telescopes, it really doesn't look like a crab, but the name remains.

The Solar Nebula

Nebulae might seem remote and unimportant here on Earth. After all, the nebulae that we observe with telescopes are many light-years away. In fact, however, our very own solar system formed about 4.6 billion years ago from a nebula known as the Solar Nebula.

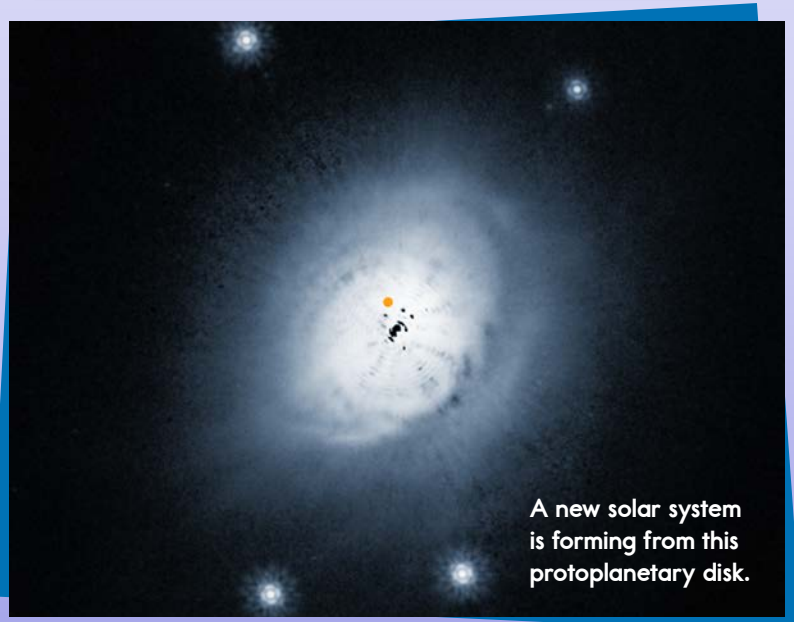


source: CalTech/JPL

Right now, the Sun is very stable, but in about 5 billion years, it will change a lot. Then, the Sun will swell up to form a much larger, *red giant* star. It may then shed off layers of gas and form a stellar remnant nebula. Over time, this matter may join with other interstellar material to form a larger nebula and then collapse again to form a new star system.

Math Moment

One *light-year* is the distance light travels in one year. When we see something that is one light-year away, we actually see what it looked like one year ago. If a certain nebula formed from a supernova that people saw 2,000 years ago, and it is 6,500 light-years away, when did the supernova happen?



A new solar system is forming from this protoplanetary disk.

Read-Think-Write

Write your answers on separate paper. Use details from the text as evidence.

1. What are *nebulae*?
2. A *remnant* is something left over, like remnants of cloth not used when making a dress. Why do you think some gas clouds in space are called *remnant nebulae*?
3. When light coming from a star bounces off the dust and gas in a nebula, the light is
   - Ⓐ being emitted by the star and reflected off the nebula.
   - Ⓑ being reflected from the star and absorbed by the nebula.
   - Ⓒ being absorbed by the star and emitted by the nebula.
4. Nebulae and stars have a similar composition of elements. What distinguishes a nebula from a star?
5. Why is the Solar Nebula important in the history of our solar system?

FOCUS Question

What is the relationship between nebulae and stars? Explain why nebulae could be considered "star recycling systems."