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Hubble: An Out-of-This-World Telescope

Written by Amy S. Hansen

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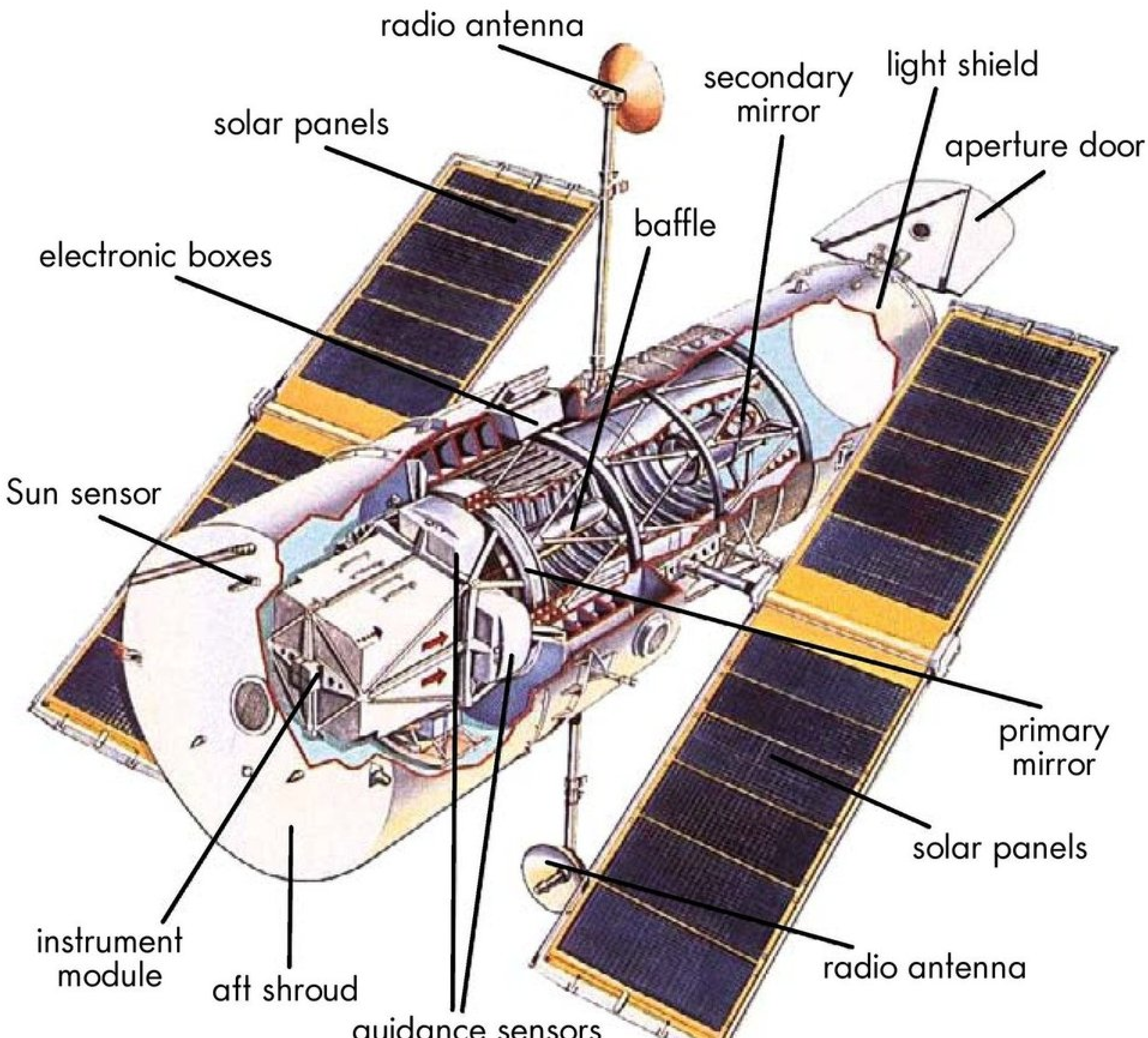
An Out-of-This-World
Telescope



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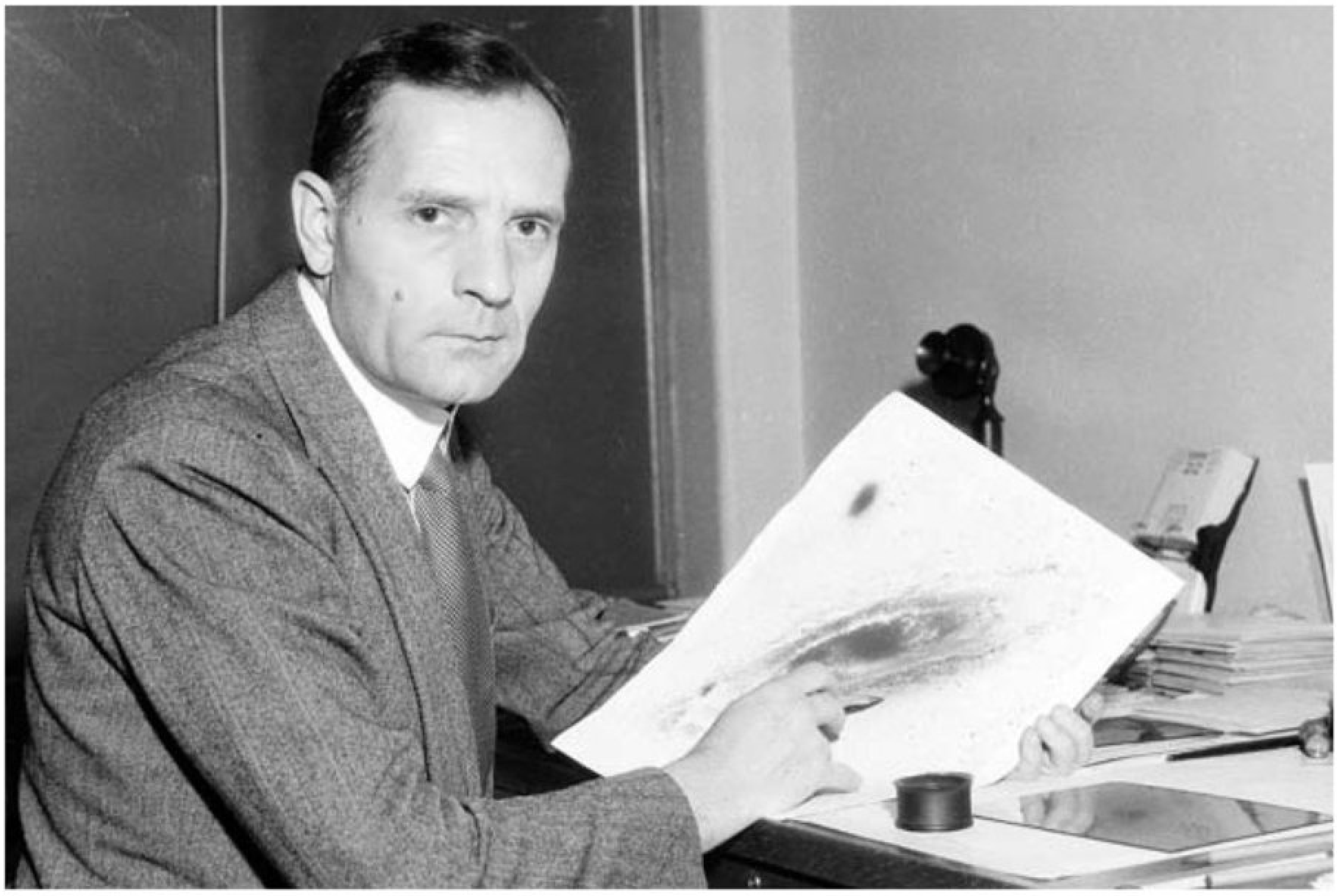

Edwin Hubble was an American astronomer whose discoveries led to a much deeper understanding of our universe. NASA named the Hubble Space Telescope after him to honor his work.

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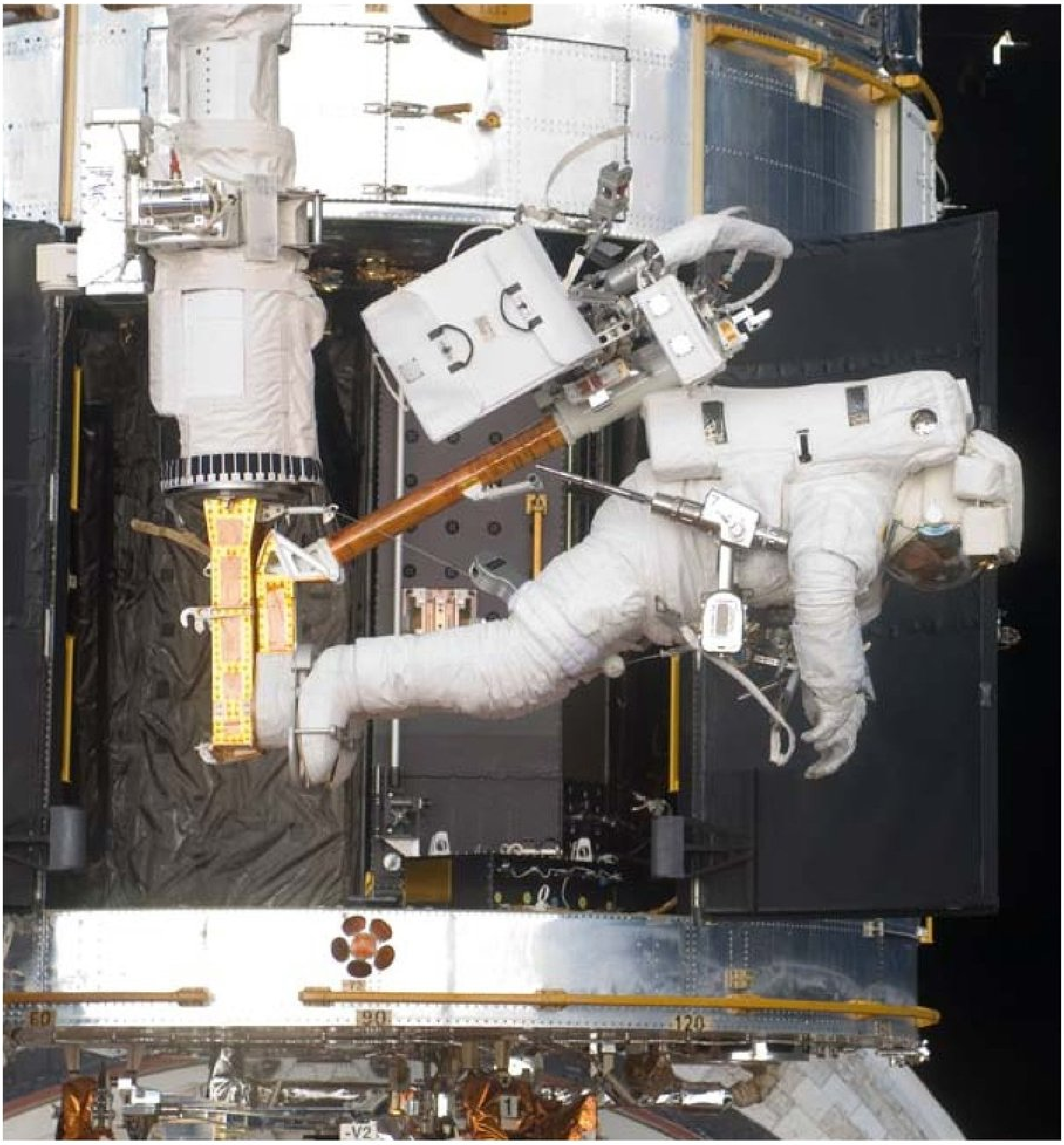
Introduction

Look into the sky on a clear night. That **multitude** of stars is what the Hubble Space Telescope sees all the time, only better. The Hubble Telescope doesn't sit on the ground. It **orbits** Earth, circling high above the planet's **atmosphere**.

The atmosphere is very important to life on Earth, but the atmosphere causes problems for telescopes. It blocks out some kinds of light, which is what makes stars look as though they twinkle. **Astronomers** solved the problem of having to look through the atmosphere to study objects in space by launching the Hubble Space Telescope. Because the Hubble is outside the atmosphere, it can see objects more clearly than telescopes on Earth.



An astronaut installs new equipment during a visit to the Hubble Space Telescope.

Hubble's New Eyes

The Hubble is one of the best telescopes that astronomers have. The telescope's images show stars forming, stars dying, and the universe expanding. Recently, astronauts visited the Hubble in space to install new equipment. With the new instruments in place, the Hubble can see better than ever.

Mike Massomino works in orbit high above Earth.

Astronaut Faces Danger During Hubble Mission Space Walk

May 17, 2009 — Astronaut Mike Massomino stepped out of the space shuttle *Atlantis* to work on the Hubble. Mike's job for this space walk was to take out the old *spectrograph*—a machine used to examine different gases—and replace it with a new one.

The last three days had been filled with space walks. The work was difficult. Astronauts were wearing bulky spacesuits that were hard to move in. Engineers had to make new tools for the job. No one knew if all the changes would work.

Mike picked up his new power tool. The first part of the task was to take off one of the Hubble's outside handles. Then he could remove the panel to get inside the telescope. Mike had rehearsed this task over and over again in practice runs. He removed one, two, three bolts. But the fourth bolt wouldn't move. Mike tried again. The bolt stayed stuck.

Mike told ground control about the problem. Then he waited, floating 569 kilometers (353 mi) above Earth. The *Atlantis* repair mission was the last time anyone planned to work on the telescope.

Ground control told Mike to use a pair of pliers to break off the handle. This procedure was dangerous because a sharp piece of metal could puncture Mike's gloves and kill him. But Mike smiled at the solution. He carefully pinched the handle with the pliers, pulled it back, and broke it. Then he and his partner opened the panel, pulled out the old instrument, and put in the new one. Ground control and the other astronauts cheered.

During the five days of space walks, the Hubble got two new cameras, two kinds of spectrographs, new computers, and new batteries. With everything in place, the *Atlantis* crew put the telescope back into orbit and waved good-bye.

Carina Nebula: A Star Nursery

One of the Hubble's new cameras takes amazing pictures of baby stars. (Astronomers use this term for new stars, even though they know stars are not actually born.) Stars form in clouds of spinning gas such as those found in many **nebulas**. The Carina Nebula is a cloud of dust and gas in space that gives scientists a chance to see stars forming.

New stars form from hydrogen gas and dust in the Carina Nebula.

The Carina Nebula has huge **plumes** of dust. Some of them cover more than three hundred **light years** of space. One light year is the distance that light travels in one year—so it would take three hundred years for light to travel across the nebula. The Carina Nebula also has a large collection of stars. Those stars pull on each other and move the cloud of dust around.

Astronomers love to look at this changing nebula. Before the Hubble's new camera was installed, they knew the Carina Nebula was forming stars, but they couldn't see the actual process.

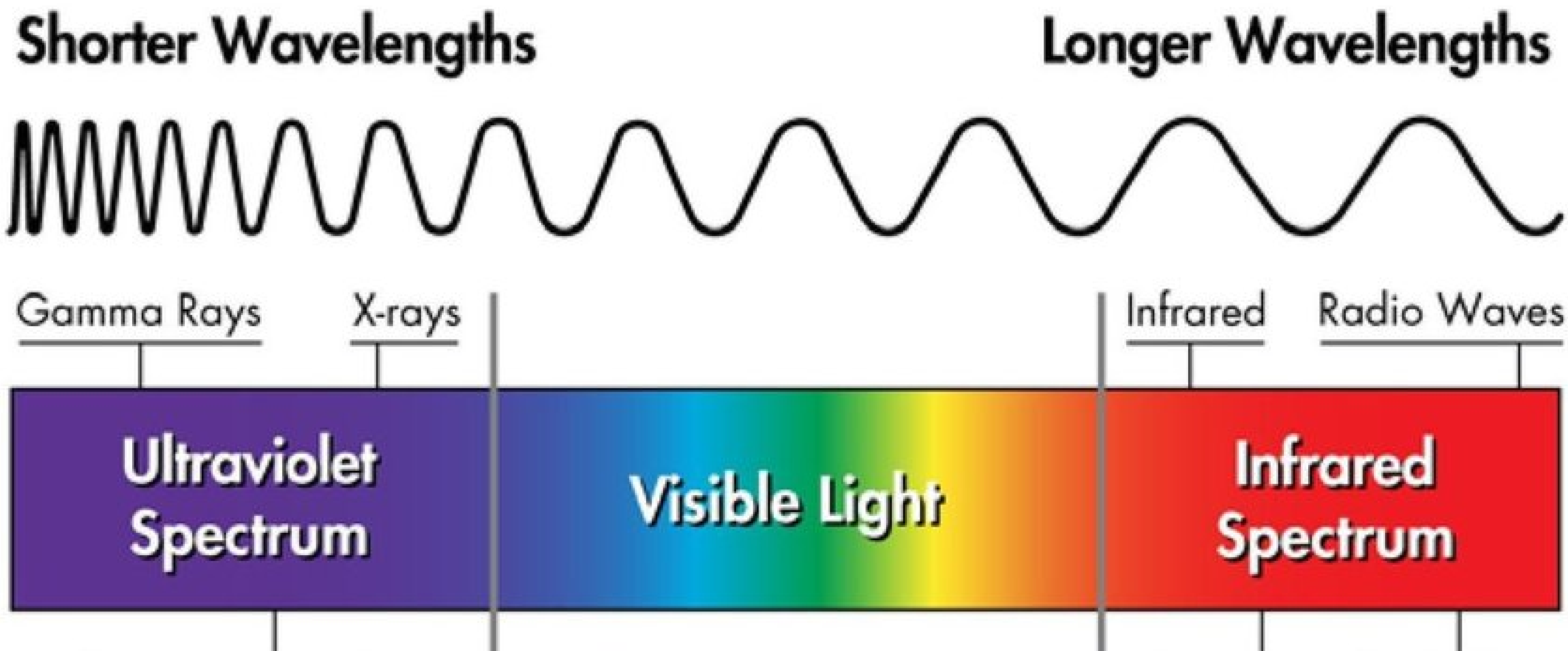
Once the new camera was installed, astronomers focused it on the nebula. They used visible light to take pictures that show the dark, swirling dust. Then astronomers changed the camera to view **infrared light**. Infrared is a type of light that humans cannot see. When the camera takes infrared pictures, the computer colors the image with "false" colors so people can see them. The infrared camera looked right through the clouds of dust to see the gases spinning at over 1.3 million kilometers per hour (850,000 mph). These swirlings are baby stars that are just starting to grow.

Different Kinds of Energy

Light is a kind of energy that moves in waves. Scientists measure it in wavelengths, or the distance from the top of one wave to the top of the next wave. Humans can see the energy called visible light, but there are many other kinds of energy we can't see.

Gamma rays, X-rays, and ultraviolet light have shorter wavelengths than visible light. Infrared, microwave, and radio energy have longer wavelengths than visible light.

Most telescopes are designed to "see" only one or two of these energy types. The Hubble is unusual in that it can measure ultraviolet, visible, and even some of the infrared wavelengths. Combining these different views into one picture can produce incredibly beautiful and informative images of objects in our universe.



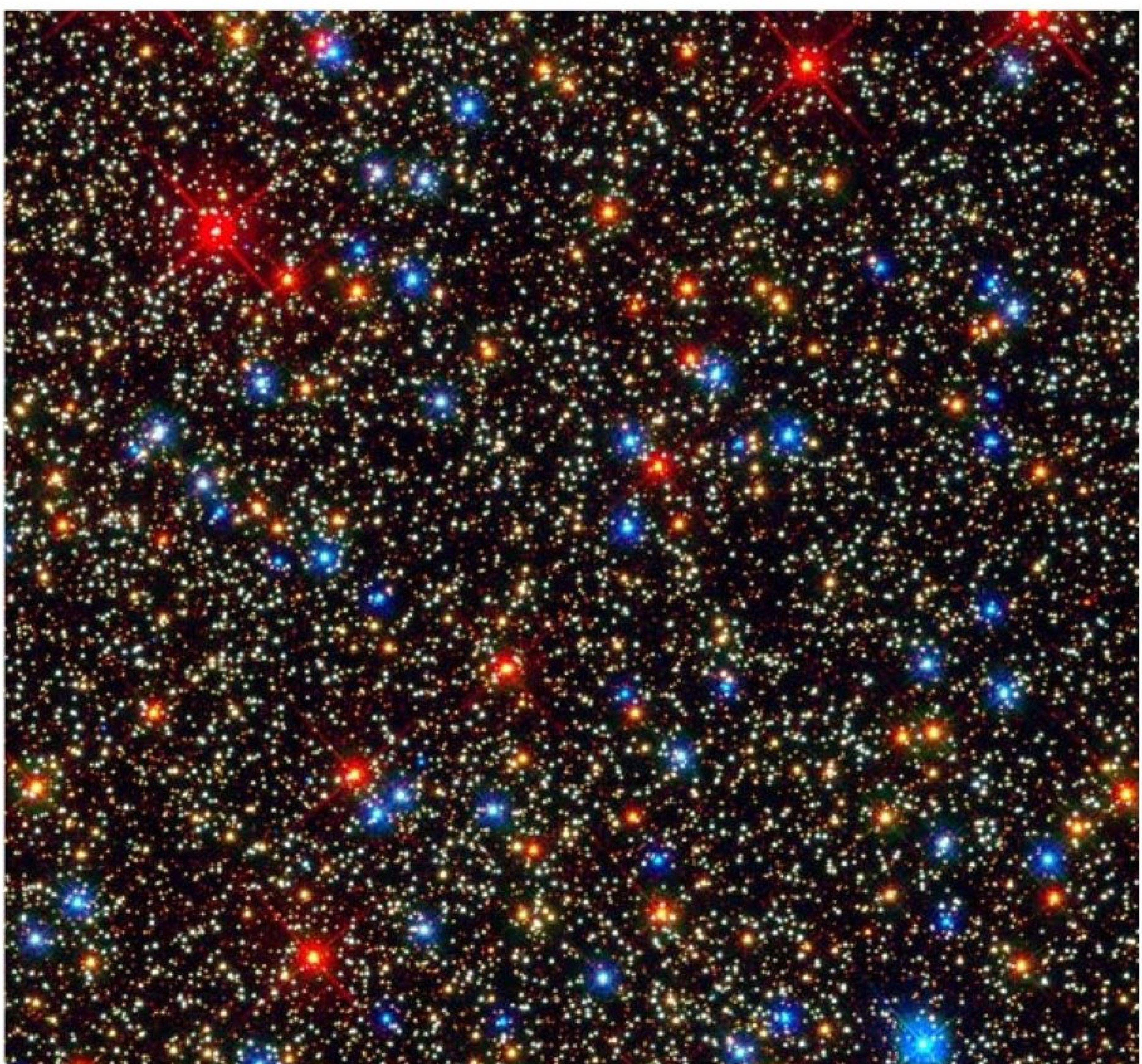
The Hubble Space Telescope took this image of NGC 1850, a double cluster in one of our neighboring galaxies.

Omega Centauri: A Globular Cluster

Astronomers pointed the upgraded Hubble Space Telescope at Omega Centauri, a huge group of stars—ten million or more. When that many stars group together in space, we call them a *globular cluster.* Omega Centauri was a place where the Hubble had looked before. But now, with the new instruments installed, astronomers hoped to learn even more.

The cluster shows stars in different age groups. Most of the stars start out yellow, like our sun. As they get older, they balloon out, becoming larger and red. In the last phase, the stars turn blue. These dying stars are smaller and hotter than the others.

The new images may hold the clue to a mystery. Scientists say that some of the pictures show a blank spot. The stars around the blank spot look as though they are being pulled inside. That blank spot might be a black hole—a kind of **vacuum** in space. Because black holes generate amazing amounts of gravity, they would pull hard on the stars. Scientists think that the presence of a **black hole** would help to explain why the stars stayed together in a cluster.



The Hubble can now show more clearly the colors of the stars in Omega Centauri. Yellow stars are young, red stars are older, and blue stars are the oldest.

Stephan's Quintet

The five galaxies in Stephan's Quintet appear to be fighting. The Hubble's improved equipment better shows how the galaxies are pulling on each other and have grown loops and tails instead of having the normal rounded shape. This tug of war happens when galaxies are close to each other. Eventually, at least one of the galaxies will get pulled into another one. However, their **collision** will not make a loud crash because sound does not travel through the emptiness of space.

Stephan's Quintet is named for French astronomer Édouard Stephan, who first described it in 1877.

The bright dot near the center of this Hubble image is a young star. Its crescent-shaped bow shock is just to its right.

Moving stars are silent, but their effects can be dramatic. When a star moves, it creates a *bow shock*. A bow shock is the energy from an object pushing forward. This energy is like a bow wave that a ship makes as it moves through the water. The larger the ship, the bigger the bow wave. Since stars are huge, their bow shocks can affect objects far away.

Scientists say that the Hubble's improved view of Stephan's Quintet may help them to understand what happened when the universe was young, some fourteen billion years ago. Back then, more stars were close together, so more collisions took place—and many more bow shocks formed.

Butterfly Nebula

The updated Hubble Space Telescope also took amazing images of the Butterfly Nebula, such as the one on the following page. If you think the Butterfly Nebula looks **fragile**, look again. Those soft wings are actually super-hot gas. The gas is shooting out of a star in the center. The "wings" of the Butterfly Nebula's gas cloud stretch more than two light years across.

Astronomers say the Butterfly Nebula is both lovely and **informative**. The nebula is caused by a dying star. The star was once about five times the size of our sun. However, it has been **ejecting** gas and shrinking for the last 2,200 years. Scientists say our sun might die in the same manner in another five billion years.

Astronomers are also watching this nebula to learn more about how the universe recycles. The gases do not just float forever in space; they get used again. The Butterfly Nebula's clouds contain the **elements** hydrogen, helium, and carbon. These elements will all eventually become part of a new star or a new planet. In fact, the carbon that helps make up every person on Earth was once part of a star.

The Butterfly Nebula has a fiery, dying star at its center.


An exploding star left behind this massive cloud of gas and dust.

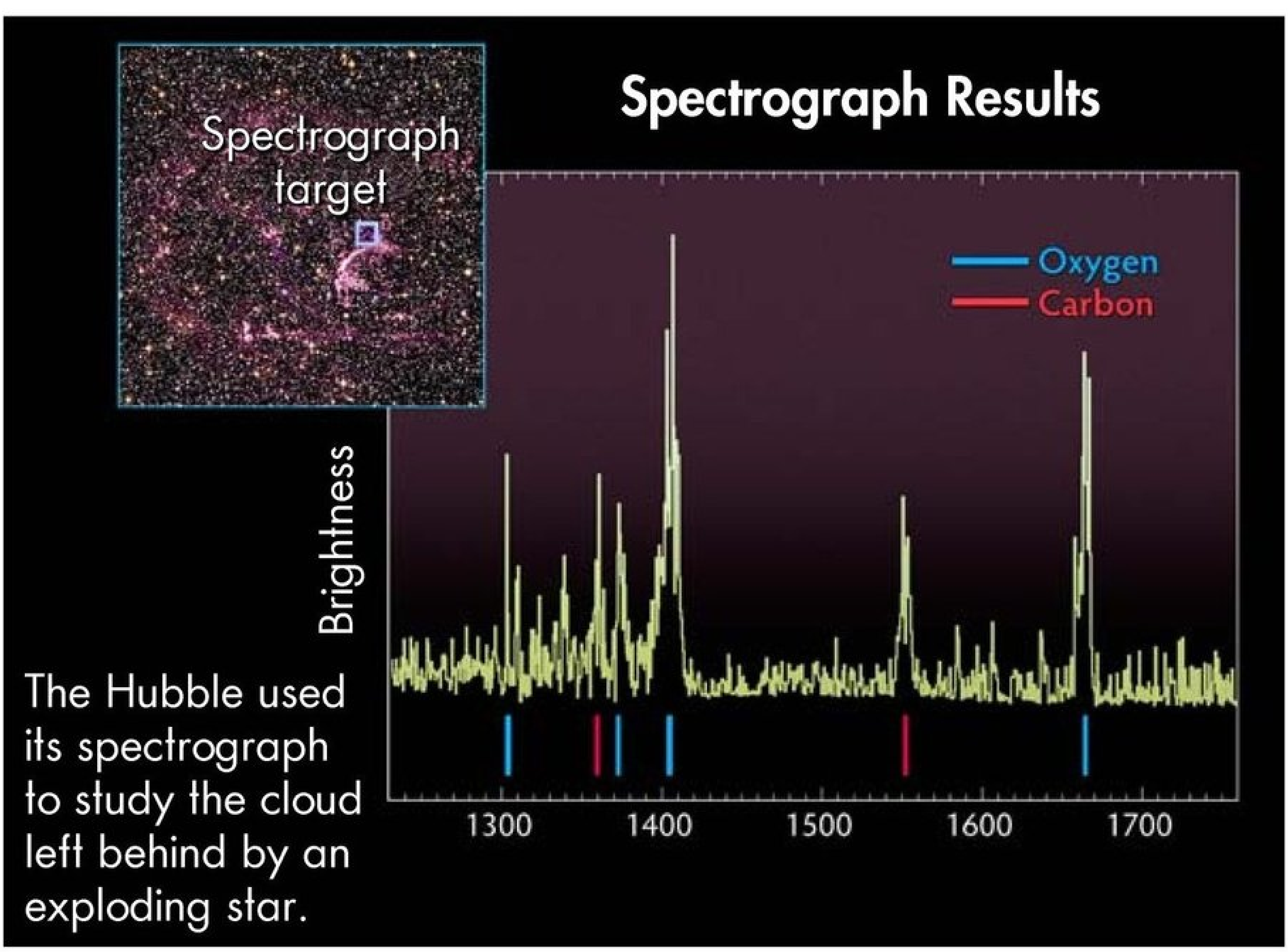
Chemical "Fingerprints" in Space

Space is not empty. Gas, dust, planets, and stars all make up a cosmic web. Astronomers use new instruments on the Hubble to map the universe.

The Hubble uses two **spectrographs** to identify different kinds of matter in space. Using the measurements, astronomers learn four things about each object they observe. They learn the temperature of the object, its **density** (how "solid" it is), the chemical elements it contains, and how fast it is moving.

The spectrographs measure the light that bounces off the gases and dust. Each chemical element looks different from the others. Hydrogen looks different from helium, helium looks different from nitrogen, and so on. Also, warmer objects look different from colder ones. Solid objects look different from gases, and faster objects look different from slower ones.

The information these instruments produce does not look like the pictures of the nebula or the globular cluster. This information is presented as a series of lines that are a sort of chemical "fingerprint." The lines show how much hydrogen, helium, and other matter is in one spot in space.



The Hubble used its spectrograph to study the cloud left behind by an exploding star.

History of the Hubble Space Telescope

Astronomers first started using the Hubble to peer into the universe in 1990. When it was first released into orbit from the cargo bay of the shuttle *Discovery*, people were excited about the possibilities. However, there was a big **glitch**. The telescope's main mirror had a tiny imperfection. The mirror is used to collect and focus light on the instruments. The mirror was off by 1/50th of the thickness of a piece of paper. That amount was enough to make the telescope's images look blurry and slightly out of focus.

Technicians work on the Hubble Space Telescope's main mirror assembly.

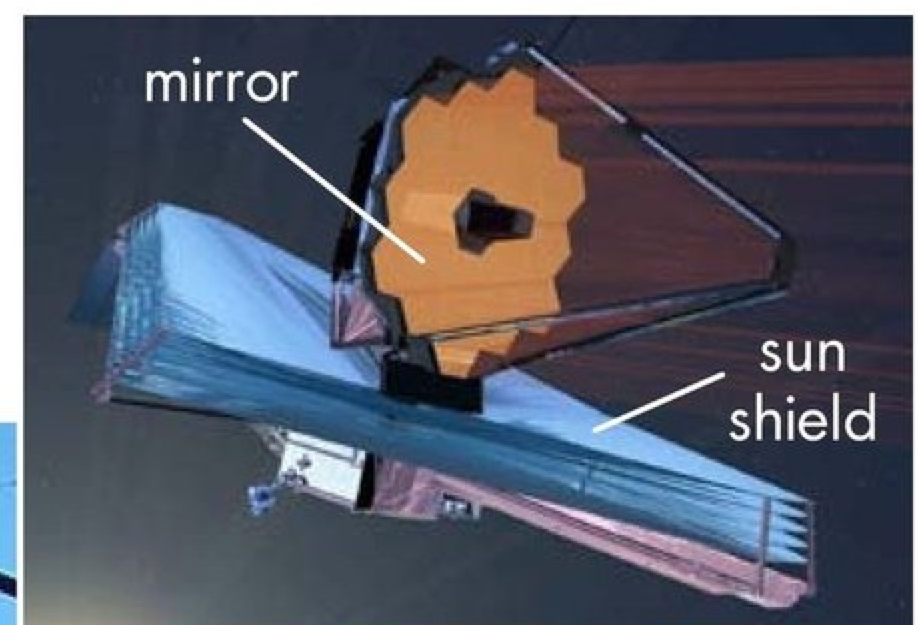
In 1993, astronauts flew to the Hubble and repaired it. After that, the images surprised everyone. No one knew that the telescope would be a source of so much information and beauty. Astronauts visited the telescope four more times. They updated its equipment, proving that astronauts could do **complex** work in space.

With its new equipment installed in 2009, the Hubble looks deeper into the universe than ever before. It can see stars that are dying and stars that are just starting out. Understanding how the universe is put together will help people travel through space. It will also help people who hope to find life on other planets.

With its new computers and batteries, the Hubble is expected to continue working at least through 2014, when the James Webb Space Telescope (JWST) will be launched.

A "Cool" Future: The James Webb Space Telescope

The JWST will be cool in more ways than one; engineers are designing the JWST to make sure that the telescope will not heat up in space. If the telescope gets too warm, it won't pick up tiny levels of infrared light. Engineers have built a sun shield the size of a tennis court that will keep the telescope in the shade so it will stay cool enough to do its job.



The James Webb Space Telescope will look even farther out into the universe than the Hubble can. It will uncover more information about new stars being born and other stars dying.

The Hubble has captured many amazing images since it was launched in 1990. Visit www.hubblesite.org to learn more.

The new telescope is expected to launch in 2014. It’s bigger than the Hubble and lighter. The whole JWST, including the giant sun shield, will fold up to squeeze into a five-meter cargo bay and then unfold in space. Once there, it will begin its job of taking a long, deep look at our universe.

Glossary

astronomers *(n.)*	scientists who study planets, stars, galaxies, and other objects in space (p. 4)
atmosphere *(n.)*	a layer of gases surrounding a planet, star, or moon (p. 4)
black hole *(n.)*	a region of space with a gravitational field so intense that nothing can escape (p. 12)
collision *(n.)*	the violent or forceful impact of two particles or bodies (p. 13)
complex *(adj.)*	difficult to achieve or understand (p. 20)
density *(n.)*	the degree of compactness of a substance (p. 17)
ejecting *(v.)*	throwing out or off from within (p. 15)
elements *(n.)*	substances that cannot be broken down into simpler substances by chemical means (p. 15)
fragile *(adj.)*	easily damaged or broken; delicate (p. 15)
glitch *(n.)*	a minor problem that causes a temporary setback (p. 19)

informative *(adj.)*	instructive (p. 15)
infrared light *(n.)*	a type of electromagnetic radiation with a longer wavelength than visible light (p. 9)
light years *(n.)*	units of distance equal to the distance that light travels in one year; about 9.46 trillion kilometers (5.88 trillion mi) (p. 9)
multitude *(n.)*	a large number of items (p. 4)
nebulas *(n.)*	regions or clouds of interstellar dust and gas appearing as bright or dark patches (p. 8)
orbits *(v.)*	revolves around another object (p. 4)
plumes *(n.)*	long clouds or masses of other material in the shape of feathers (p. 9)
spectrographs *(n.)*	instruments used to measure and record electromagnetic radiation (p. 17)
vacuum *(n.)*	a space that contains absolutely no matter (p. 12)

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