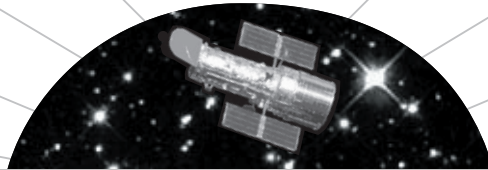




THE STAR★WITNESS



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Special Feature

Hubble Is Back in Business

By NASA's Amazing Space reporters
September 2009

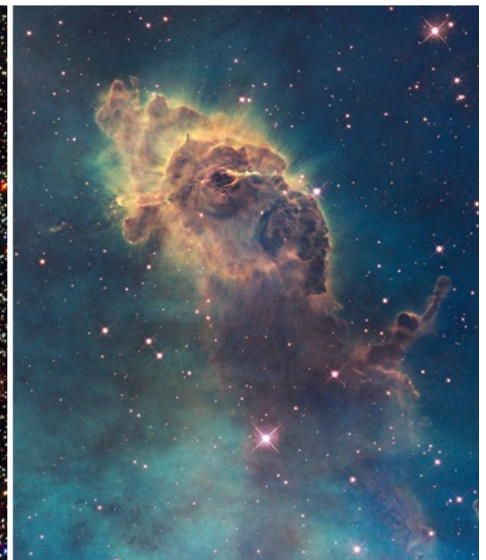
THE UPGRADED Hubble Space Telescope has reopened its eye on the universe, producing several breathtaking images.

Topping the list of exciting new views are colorful pictures of a clash between several galaxies, a "butterfly" nebula, a densely packed star cluster, and an eerie, dense pillar of gas and dust where new stars are being born. The first snapshots from the refurbished Hubble showcase the telescope's new vision.

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**At right: ▶
Hubble's new views
of the universe**

These four images are among the first observations made by the new Wide Field Camera 3 aboard the upgraded NASA Hubble Space Telescope. See enlargements and descriptions of the images on the following pages.



NASA, ESA, and the Hubble SM4 ERO Team

Butterfly emerges from stellar death in planetary nebula



NASA, ESA, and the Hubble SM4 ERO Team

Astronauts make servicing mission a success

The telescope took a break from observing the universe after a successful servicing mission in May 2009. During the break, NASA engineers and scientists put the telescope and its instruments through rigorous tests to ensure everything was working properly.

NASA astronauts visited the telescope for the final time in May to upgrade and repair the 19-year-old Earth-orbiting observatory. During five grueling spacewalks, the astronauts completed a long list of activities, including adding two new science instruments, the Wide Field Camera 3 and the Cosmic Origins Spectrograph. They also replaced aging gyroscopes and batteries and an ailing science data computer.

Upgrades and repairs enhance Hubble's vision

The Wide Field Camera 3 will greatly improve Hubble's ability to observe distant objects, such as galaxies, as well as planets in our solar system. It will detect light ranging from ultraviolet, to visible, to near-infrared.

The Cosmic Origins Spectrograph is the most powerful spectrograph ever sent to space. The instrument will not snap the beautiful images of the universe for which Hubble is famous. Its job is to separate light into its component wavelengths, which will yield information about the composition and temperature of distant galaxies, stars, and planets.

During the May servicing mission, the astronauts also revived two older science instruments, the Advanced Camera for Surveys and the Space Telescope Imaging Spectrograph,

which were not designed to be repaired in space. The upgrades and repairs will extend Hubble's life through the next decade.

The best is yet to come

Now that Hubble is back in business, scientists will use the landmark observatory to observe a broad range of celestial targets. Astronomers, for example, have ambitious plans to use Hubble to make the deepest-ever portrait of the universe in near-infrared light. The resulting picture may reveal never-before-seen infant galaxies that existed when the universe was less than 500 million years old. Other observations include taking a census of Kuiper Belt objects — icy comets residing at the fringe of our solar system, observing the birth of planets around other stars, and probing the composition and structure of the atmospheres of other worlds. ★

◀ **Butterfly nebula (p. 2):**

Ordinary stars like our Sun live undistinguished lives. They steadily churn out heat and light for billions of years. Oddly enough, their lives become more exciting when they run out of hydrogen fuel and reach retirement age. This is when these stars begin to stand out. They begin shedding their layers of material, forming beautiful shapes. This celestial object for example, was once an ordinary star that evolved into a delicate-looking butterfly.

The Butterfly Nebula, catalogued as NGC 6302, was a dying star that was once about five times the mass of the Sun. It has ejected its layer of gases and is now unleashing a stream of ultraviolet radiation that is making the ejected material glow. This object is an example of a planetary nebula, so-named because many of them have a round appearance resembling that of a planet when viewed through a small telescope.

NGC 6302 lies within our Milky Way galaxy, roughly 3,800 light-years away in the constellation Scorpius. The glowing gas is the star's outer layers, expelled about 2,200 years ago. The central star itself cannot be seen, because it is hidden within a doughnut-shaped ring of dust, which appears as a dark band pinching the nebula in the center. The "butterfly" stretches for more than two light-years, which is about half the distance from the Sun to the nearest star, Alpha Centauri.

The Wide Field Camera 3 (WFC3), a new camera aboard NASA's Hubble Space Telescope, snapped this image of the planetary nebula.

Galactic wreckage in Stephan's Quintet

Close encounters distort some of the galaxy shapes below. See caption, page 5, for full story.



NASA, ESA, and the Hubble SM4 ERO Team

Colorful stars galore inside a globular star cluster



NASA, ESA, and the Hubble SM4 ERO Team

◀ Stephan's Quintet (p. 4):



A clash among members of a famous galaxy quintet reveals an assortment of stars across a wide color range, from young, blue stars to aging, red stars.

This portrait of Stephan's Quintet was taken by the new Wide Field Camera 3 (WFC3) aboard NASA's Hubble Space

Telescope. Stephan's Quintet, as the name implies, is a group of five galaxies. The name, however, is a bit of a misnomer. Studies have shown that the group member at upper left is actually a foreground galaxy about seven times closer to Earth than the rest of the group.

Three of the galaxies have distorted shapes, elongated spiral arms, and long, gaseous tidal tails containing many star clusters, proof of their close encounters. These interactions have sparked a frenzy of star birth in the central pair of galaxies. This drama is being played out against a rich backdrop of faraway galaxies.

The fifth galaxy at bottom left, is a normal-looking elliptical galaxy that is less affected by the interactions.

These Hubble observations are part of the Hubble Servicing Mission 4 Early Release Observations. NASA astronauts installed the WFC3 camera during a servicing mission in May to upgrade and repair the 19-year-old Hubble telescope.



▲ Crowded, colorful core of a globular cluster:

NASA's Hubble Space Telescope snapped this panoramic view of a colorful assortment of 100,000 stars residing in the crowded core of a giant star cluster.

The image reveals a small region inside the massive globular cluster Omega Centauri, which boasts nearly 10 million stars. Globular clusters, ancient swarms of stars united by gravity, are the homesteaders of our Milky Way galaxy. The stars in Omega Centauri are between 10 billion and 12 billion years old. The cluster lies about 16,000 light-years from Earth.

This is one of the first images taken by Hubble's new Wide Field Camera 3 (WFC3). The camera can snap sharp images over a broad range of wavelengths.

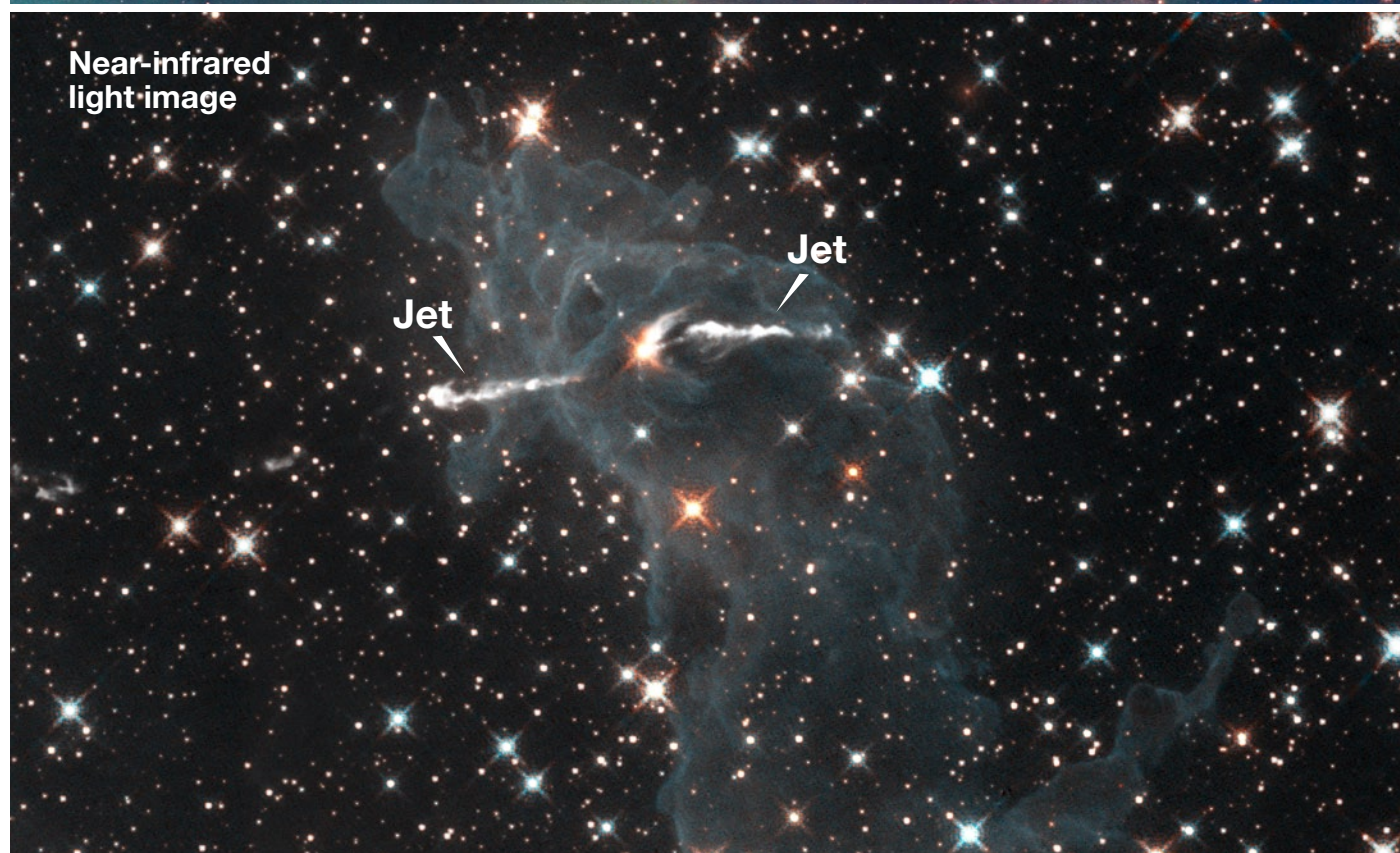
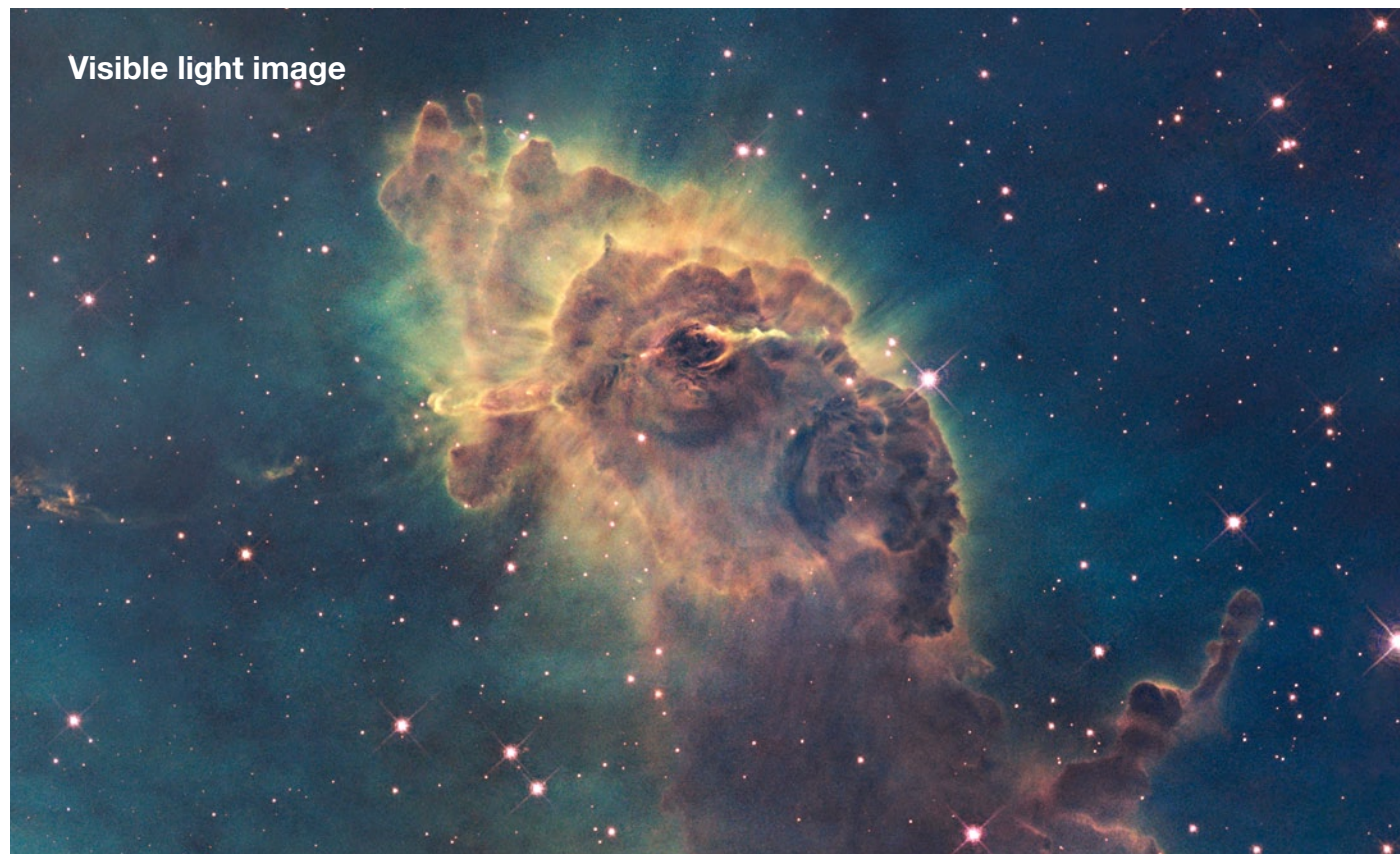
The majority of the stars in the image are yellow-white, like our Sun. These are adult stars that are shining by hydrogen fusion. The red, orange, and blue stars are in a later stage of life.

All of the stars in the image are cozy neighbors. The average distance between any two stars in the cluster's crowded core is only about a third of a light-year, roughly 13 times closer than our Sun's nearest stellar neighbor, Alpha Centauri. Although the stars are close together, WFC3's sharpness can resolve each of them as individual stars. If anyone lived in this globular cluster, they would behold a star-saturated sky that is roughly 100 times brighter than Earth's sky.

Omega Centauri is among the biggest and most massive of some 200 globular clusters orbiting the Milky Way. It is one of the few globular clusters that can be seen with the unaided eye. It resembles a small cloud in the southern sky and might easily be mistaken for a comet.

Stars bursting to life in the chaotic Carina Nebula

Stellar “jet” blasts from an infant star. See caption, page 7, for full story.



NASA, ESA, and the Hubble SM4 ERO Team

◀ **Star birth revealed inside gaseous pillar (p. 6):**

These two images of a huge pillar of star birth demonstrate how observations taken in visible and in infrared light by NASA's Hubble Space Telescope reveal dramatically different and complementary views of an object.

The pictures demonstrate one example of the broad wavelength range of the new Wide Field Camera 3 (WFC3) aboard the Hubble telescope, extending from ultraviolet to visible to near-infrared light.

Composed of gas and dust, the pillar resides in a turbulent stellar nursery called the Carina Nebula, located 7,500 light-years away in the southern constellation Carina. The pair of images shows that astronomers are given a much more complete view of the pillar and its contents when distinct details not seen at visible wavelengths alone are uncovered in near-infrared light.

The top image (p. 6), taken in visible light, shows the tip of the 3-light-year-long pillar, bathed in the glow of light from hot, massive stars off the top of the image. Scorching radiation and fast winds (streams of charged particles) from these stars are sculpting the pillar and causing new stars to form within it. Streamers of gas and dust can be seen flowing off the top of the structure.

Nestled inside this dense structure are fledgling stars. They cannot be seen in this image because they are hidden by a wall of gas and dust. Although the stars themselves are invisible, one of them is providing evidence of its existence. Thin puffs of material can be seen traveling to the left and to the right of

a dark notch in the center of the pillar. The matter is part of a jet produced by a young star. Farther away, on the left, the jet is visible as a grouping of small, wispy clouds. A few small clouds are visible at a similar distance on the right side of the jet. Astronomers estimate that the jet is moving at speeds of up to 850,000 miles an hour. The jet's total length is more than 10 light-years.

In the image at bottom (p. 6), taken in near-infrared light, the dense column and the surrounding greenish-colored gas all but disappear. Only a faint outline of the pillar remains. By penetrating the wall of gas and dust, the near-infrared vision of WFC3 reveals the infant star that is probably blasting the jet. Part of the jet nearest the star is more prominent in this view. These features can be seen because infrared light, unlike visible light, can pass through the dust.

Other infant stars inside the pillar also appear to emerge. Three examples are the bright star almost directly below the jet-producing star, a fainter one to its right, and a pair of stars at the top of the pillar. Winds and radiation from some of the stars are blowing away gas from their neighborhoods, carving out large cavities that appear as faint dark holes.

Surrounding the stellar nursery is a treasure chest full of stars, most of which cannot be seen in the visible-light image because dense gas clouds veil their light. Many of them are background stars.

Hubble's Wide Field Camera 3 observed the Carina Nebula on July 24-30, 2009. WFC3 was installed aboard Hubble in May 2009 during Servicing Mission 4.

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NASA's award-winning educational Web site for
K-12 students and teachers.

