

EUROPEAN SPACE AGENCY Hubble Space Telescope 30th Anniversary Press Package



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The Hubble Space Telescope



Timeline History of the Hubble Space Telescope

- 1923:** The rocket scientist Hermann Oberth publishes an article in which he proposes the idea of a telescope in orbit of Earth.
- 1946:** The astronomer Lyman Spitzer writes a report on the advantages of an extraterrestrial observatory.
- 1975:** ESA joins NASA in the endeavour to realise a large Space Telescope, as a 15% partner.
- 1977:** The American Congress approves the funding for the Large Space Telescope.
- 1978:** Astronauts begin the training for space telescope missions.
- 1979:** Work begins on the 2.4-metre main mirror of the telescope.
- 1981:** The Space Telescope Science Institute (STScI) begins its operations on the campus of the Johns Hopkins University in Baltimore, USA.
- 1983:** The Large Space Telescope is renamed the Hubble Space Telescope, after the renowned astronomer Edwin Powell Hubble, who proved the existence of other galaxies and discovered the first evidence for an expanding Universe.
- 1984:** The Space Telescope-European Coordinating Facility begins its operation in Garching at Munich, Germany.
- 1985:** The work on building Hubble is completed.
- 1986:** Hubble's launch is delayed after the Challenger disaster, which puts all shuttle flights on hold.
- 1990:** The shuttle Discovery (STS-31) is launched on 24 April 1990 and brings Hubble into space. On 25 April Hubble is deployed into its orbit by the space shuttle crew. The first images made on 25 June reveal that the main mirror of Hubble has a spherical aberration which causes all images to be blurred. Within the same year COSTAR is approved: This instrument is a complex package of five optical mirror pairs which are going to rectify the spherical aberration of Hubble's main mirror.

- 1993:** The space shuttle Endeavour is launched on 2 December to conduct the first servicing mission on Hubble. During the mission the corrective optics of COSTAR are installed which replace the High Speed Photometer. The WFPC2 (Wide Field and Planetary Camera 2), which was built with its own corrective optics, replaced the WFPC1 (Wide Field and Planetary Camera 1)
- 1994:** Hubble provides detailed observations of the comet Shoemaker–Levy 9 as it collides with the planet Jupiter [1]. In addition, by observing the galaxy M87 Hubble provides conclusive evidence for the existence of Supermassive Black Holes in the centres of galaxies [2].
- 1995:** Hubble takes the famous photo of the Eagle Nebula which later will be called “the pillars of creation” [3].
- 1996:** The first Hubble Deep Field, which was observed by the end of 1995, is revealed and allows astronomers to study galaxies in the early Universe [4]. In the same year Hubble resolves the host galaxies of quasars [5].
- 1997:** Servicing Mission 2 (STS-82) is launched on 11 February. The crew of the space shuttle Discovery replace the instruments FOS (Faint Object Spectrograph) and GHRS (Goddard High Resolution Spectrograph) with STIS (Space Telescope Imaging Spectrograph) and NICMOS (Near Infrared Camera and Multi-Object Spectrograph). Within 1997 Hubble also observes the visible afterglow of a gamma-ray burst in a distant galaxy [6].
- 1998:** On 29 October the HST Orbital System Test (HOST) is launched with the space shuttle Discovery (STS-95). The HOST mission is testing new technologies to be used in Hubble on the third Servicing Mission and beyond.
- 1999:** The Servicing Mission 3A (STS-103) is launched on 19 December. The astronauts on board the Discovery replace the six gyroscopes of the telescope, which help it pointing at celestial objects, and conduct a general maintenance. This is the first servicing mission which is not replacing any older science instruments.
- 2001:** Hubble is able to measure the elements on the atmosphere of the exoplanet HD 209458b [7].
- 2002:** The Servicing Mission 3B which is launched on 1 March. During the Mission the ACS (Advanced Camera for Surveys), the NICMOS Cooling System (NCS) and new solar panels are installed. Hubble also detects an object in the Kuiper belt at the edge of our Solar System which is larger than Pluto [8]. This discovery leads to a debate on Pluto’s status as a planet.
- 2003:** The space shuttle Columbia disintegrates during the atmospheric re-entry, no crew members survive and the shuttle programme is grounded.
- 2004:** The Hubble Ultra Deep Field is released allowing astronomers to look even further back in the time of the cosmos [9]. Another servicing mission is cancelled out of concern for shuttle safety. The power supply on STIS (Space Telescope Imaging Spectrograph) fails.
- 2005:** Hubble images two previously unknown moons orbiting Pluto [10].
- 2006:** In a reversal of a previous decision, Servicing Mission 4 will go ahead [11].
- 2007:** Hubble observations show that the dwarf planet Eris is bigger than Pluto [12]. A 3D-map, based on images by Hubble, showing the distribution of dark matter in the Universe is revealed [13]. The power supply on the Advanced Camera for Surveys, one of Hubble’s key instruments, fails.
- 2008:** Hubble takes a picture of the exoplanet Formalhaut b, the first visual image of an exoplanet [14]. In the same year Hubble finds organic molecules on an extrasolar planet and the telescope’s 100 000th orbit around Earth is celebrated [15].

- 2009:** Servicing Mission 4 (STS-125) is launched on 11 May **[16]**. The astronauts install two new instruments, WFC3 (Wide Field Camera 3) and COS (Cosmic Origins Spectrograph) which make Hubble 100 times more powerful than when it was launched. During the servicing mission the damaged instruments are repaired, the gyroscopes and batteries are replaced, and the Soft Capture Mechanism as well as NBLs (New Outer Blanket Layers) are installed.
- 2010:** Hubble images reveal distant galaxies with redshifts greater than 8, showing the Universe as it was when it was less than a tenth of its current age **[17]**. Hubble also photographs a never-before-seen evidence of a collision between two asteroids **[18]**.
- 2011:** Hubble makes its millionth observation, a spectroscopic analysis of the exoplanet HAT-P-7b. The 10 000th scientific paper using Hubble data is published **[19]**.
- 2012:** Images taken by Hubble show seven primitive galaxies from a distant population that formed more than 13 billion years ago. The galaxies are seen as they were when the Universe was less than 4 percent of its present age. Later in the year even that record is broken as Hubble finds an object back from a time when the Universe was only 3 percent of its present age, only 470 million years after the Big Bang **[20]**. Hubble observations also lead to identify a new class of exoplanet **[21]**.
- 2013:** Hubble is also used in this year to determine for the first time the true colour of a planet orbiting another star **[22]** and finds water plumes erupting off the surface of Jupiter's moon Europa **[23]**.
- 2014:** Hubble becomes the first telescope ever to observe an asteroid disintegrating **[24]** and it reveals the most detailed weather map for an exoplanet ever **[25]**.
- 2015:** Hubble observes, for the first time, four images of a distant exploding star magnified by the powerful gravity of a massive cluster of galaxies **[26]**. It also celebrates its 25th year in orbit with celebrations across the globe **[27]** **[28]**.
- 2016:** Hubble captures a detailed image of Mars **[29]**. The telescope's birthday is celebrated with a colourful view of the Bubble Nebula **[30]**.
- 2017:** Hubble observes for the first time the source of a gravitational wave, created by the merger of two neutron stars, providing the first glimpse of multi-messenger astronomy **[31]**. The travelling exhibition Our Place in Space is also launched in Venice, Italy **[32]**.
- 2018:** Hubble data helps provide the first compelling evidence for a moon outside our own Solar System **[33]** and observes the interstellar visitor Oumuamua **[34]**. Hubble also studies the atmosphere of an exoplanet (WASP-39b) in more detail than ever before **[35]**.
- 2019:** Hubble helps accurately weigh the Milky Way **[36]** and makes new observations of the interstellar comet comet 2I/Borisov **[37]**. The Hubble Legacy Field is also published **[38]**. In an exciting and popular discovery, Hubble data finds water vapour exoplanet in the habitable zone for the first time **[39]**.
- 2020:** Hubble celebrates 30 years in orbit, with a special anniversary image featuring NGC 2020 and NGC 2014 **[40]**.

Hubble Space Telescope Fact Sheet



Dimensions: Length: 13.2 metres, diameter: 4.2 metres. In addition two solar panels each of which are 2.45 x 7.56 metres.

Mass: 11 110 kg (at the time of launch).

Mirror: 2.4 metres in diameter.

Orbit: Circular orbit, approximately 543 km above the ground, inclined at 28.5 degrees to the Equator. The telescope orbits the Earth at 28 000 kilometres an hour and takes 96 minutes to complete one orbit.

Instruments: Hubble is equipped with several different instruments:

- **WFC3** — Wide Field Camera 3: The main camera of the telescope which was installed during Servicing Mission 4.
- **COS** — Cosmic Origins Spectrograph: The spectrograph was installed during Servicing Mission 4, to expand the spectroscopic capabilities of Hubble's scientific arsenal.
- **ACS** — Advanced Camera for Surveys: Repaired during Servicing Mission 4 this instrument replaced Hubble's Faint Object Camera during Servicing Mission 3B. Its wavelength range extends from the ultraviolet, through the visible and out to the near-infrared. Its wide field of view is nearly twice that of Hubble's former workhorse camera, WFPC2. Its name comes from its particular ability to map large areas of the sky in great detail. ACS can also perform spectroscopy with a special optical tool called a 'grism'.
- **STIS** — Space Telescope Imaging Spectrograph: Repaired during Servicing Mission 4 this is a versatile "combi-instrument" taking advantage of modern technologies and combines a camera with a spectrograph. It covers a wide range of wavelengths from the ultraviolet to the near-infrared region.
- **NICMOS** — Near Infrared Camera and Multi-object Spectrometer: Though not currently operational, NICMOS provided the capability for infrared imaging and spectroscopic observations of astronomical targets, detecting light with wavelengths between 800 to 2500 nanometres. These wavelengths are infrared and thus invisible to our human eyes.
- **FGS** — Fine Guidance Sensors: An optical sensor used to provide pointing information for the spacecraft and also as a scientific instrument for astrometric science.

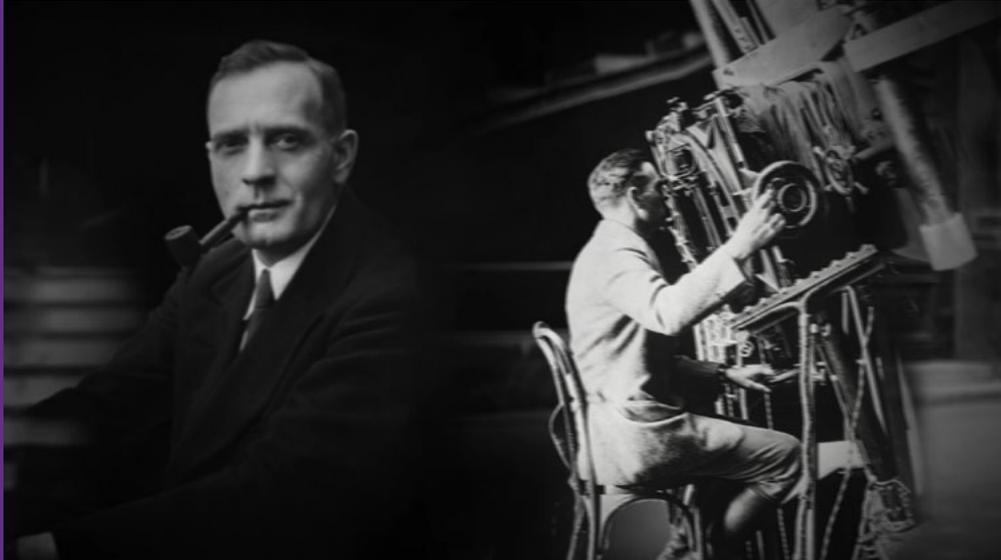
Power: Power for the computers and scientific instruments onboard is provided by two 2.45 x 7.56 metre solar panels. The power generated by the panels is also used to charge six nickel-hydrogen batteries that provide power to the spacecraft for about 25 minutes per orbit while Hubble flies through the Earth's shadow. The solar panels were already renewed twice and replaced with more modern, more efficient versions.

Pointing: The telescope uses an elaborate system of pointing controls to acquire targets and maintain stability during observations. A set of reaction wheels manoeuvres the telescope into place and its position in space is monitored by gyroscopes. Fine Guidance Sensors (FGS) are used to lock onto guide stars to ensure the extremely high pointing accuracy needed to make very accurate observations. The telescope does not have any rockets on board. Boosting the spacecraft's orbit could only be done during servicing missions, when the telescope was connected to the Space Shuttle.

Observations & Data: To date, the mission has yielded to date 1.4 million observations and provided data that astronomers around the world have used to write more than 17,000 peer-reviewed scientific publications, making it one of the most prolific space observatories in history. Its rich data archive alone will fuel future astronomy research for generations to come.



Edwin P. Hubble — The Man Behind the Name



When talking about the Hubble Space Telescope one man should not be forgotten: The man who gave the space telescope its name: Edwin Powell Hubble. Today, most astronomers see him as the most important observational cosmologist in the 20th century as he played a crucial role in establishing the field of extragalactic astronomy.

As a result of Hubble's work, our perception of mankind's place in the Universe has changed forever: humans have once again been set aside from the centre of the Universe. When scientists decided to name the Space Telescope after the founder of modern cosmology, the choice could not have been more appropriate.

Edwin Hubble was born in Missouri in 1889, the son of an insurance executive, and moved to Chicago nine years later. At his high school graduation in 1906 he gained a scholarship for the University of Chicago where he finally obtained a degree in Mathematics and Astronomy in 1910.

A tall, powerfully built young man, Hubble loved basketball and boxing, and the combination of athletic prowess and academic ability earned him a Rhodes scholarship to Oxford. There, a promise made to his dying father, led him to study law rather than science, although he also took up Literature and Spanish. He studied Roman and English Law at Oxford and returned to the United States only in 1913. Here he passed the bar examination and practised law half-heartedly for a year in Kentucky, where his family was then living.

He was also hired by New Albany High School (New Albany, Indiana) in the autumn of 1913 to teach Spanish, Physics and Mathematics, and to coach basketball. His popularity as a teacher is recorded in the school yearbook dedicated to him: "To our beloved teacher of Spanish and Physics, who has been a loyal friend to us in our senior year, ever willing to cheer and help us both in school and on the field, we, the class of 1914, lovingly dedicate this book." When the school term ended in May 1914, Hubble decided to pursue his first passion and so returned to university as a graduate student to study more astronomy.

Early in 1917, while still finishing the work for his doctorate, Hubble was invited by George Ellery Hale, founder of the Mount Wilson Observatory, in Pasadena, California, to join the staff there. This was a great opportunity, but it came in April of a dreadful year. After sitting up all night to finish his PhD thesis and taking the oral examination the next morning, Hubble enlisted in the infantry and telegraphed Hale: "Regret cannot accept your invitation. Am off to the war."

He served in France and next returned to the United States in 1919. He went immediately to the Mount Wilson Observatory, where the newly discharged Major Hubble, as he invariably introduced himself, arrived, still in uniform, but ready to start observing.

Hubble was lucky enough to be in the right place at the right time. Mount Wilson was the centre of observational work underpinning the new astrophysics, later called cosmology, and the 100-inch Hooker Telescope, then the most powerful on Earth, had just been completed and installed after nearly a decade of work.

On the mountain Hubble encountered his greatest scientific rival, Harlow Shapley, who had already made his reputation by measuring the size of the Milky Way, our own Galaxy. Shapley had used a method pioneered by Henrietta Leavitt at the Harvard College Observatory that relied on the behaviour of standardised light variations from bright stars called Cepheid variables to establish the distance of an object.

His result of 300 000 light-years for the width of the galaxy was roughly 10 times the previously accepted value. However Shapley, like most astronomers of the time, still thought that the Milky Way was all there was to the Universe. Despite a suggestion first made by William Herschel in the 18th century, he shared the accepted view that all nebulae were relatively nearby objects and merely patches of dust and gas in the sky.

Hubble had to spend many bitterly cold nights sitting at the powerful Hooker telescope before he could prove Shapley wrong. In October 1923 he spotted what he first thought was a nova star flaring up dramatically in the M31 "nebula" in the constellation of Andromeda. After careful examination of photographic plates of the same area taken previously by other astronomers, including Shapley, he realised that it was a Cepheid star. Hubble used Shapley's method to measure the distance to the new Cepheid. He could then place M31 a million light-years away - far outside the Milky Way and thus itself a galaxy containing millions of stars. The known Universe had expanded dramatically that day and - in a sense - the Cosmos itself had been discovered!

This discovery was of great importance to the astronomical world, but Hubble's greatest moment was yet to come. He began to classify all the known nebulae and to measure their velocities from the spectra of their emitted light. In 1929 he made another startling find - all galaxies seemed to be receding from us with velocities that increased in proportion to their distance from us - a relationship now known as Hubble's Law.

This discovery was a tremendous breakthrough for the astronomy of that time as it overturned the conventional view of a static Universe and showed that the Universe itself was expanding. More than a decade earlier, Einstein himself had bowed to the observational wisdom of the day and corrected his equations, which had originally predicted an expanding Universe. Now Hubble had demonstrated that Einstein was right in the first place.

The now elderly, world-famous physicist went specially to visit Hubble at Mount Wilson to express his gratitude. He called the original change of his beloved equations "the greatest blunder of my life."

Hubble worked on indefatigably at Mount Wilson until the summer of 1942, when he left to serve in World War II. He was awarded the Medal of Merit in 1946. Finally, he went back to his Observatory. His last great contribution to astronomy was a central role in the design and construction of the Hale 200-inch Telescope on Palomar Mountain. Four times as powerful as the Hooker, the Hale would be the largest telescope on Earth for decades. In 1949, he was honoured by being allowed the first use of the telescope.

During his life, Hubble had tried to obtain the Nobel Prize, even hiring a publicity agent to promote his cause in the late 1940s, but all the effort was in vain as there was no category for astronomy. Hubble died in 1953 while preparing for several nights of observations, his last great ambition fulfilled.

He would have been thrilled had he known that the Space Telescope is named after him, so that astronomers can continue to "*hope to find something we had not expected*", as he said in 1948 during a BBC broadcast in London.

The Hubble Space Telescope's 30th Anniversary

ESA/Hubble's Public Celebrations in Europe



To celebrate the NASA/ESA Hubble Space Telescope's 30 incredible years in orbit, ESA/Hubble selected over 30 education organizations and institutions across Europe to receive high-quality large-format prints of Hubble's anniversary image for display in public settings on the anniversary date (24 April 2020). The call for proposals for host institutions was released in October 2019 and the selected host locations for these unveilings was published in February 2020. The Space Telescope Science Institute (STScI) also announced coordinated unveiling plans across the United States.

Following the evolution and concerns of the COVID-19 virus in the early months of 2020, ESA/Hubble shifted its vision to instead hold events throughout 2020 that are a general celebration of the Hubble Space Telescope's splendid 30 years, as the spread of the coronavirus impacted the feasibility of hosting public events, particularly those with large audiences.

Public health is the primary priority for ESA/Hubble and its network. We look forward to celebrating Hubble and its 30th anniversary milestone throughout 2020 in various European locations. Updates will be provided regularly about these celebrations on [this page](#).

Special Anniversary Hubblecasts

Two special anniversary Hubblecasts have been developed for the Hubble Space Telescope's 30th anniversary image release. These documentary-style movies are offered for download in several formats on the SpaceTelescope.org website: standard (.mov, .mpeg, .mp4, .m4v), HD (High Definition) and Full HD.



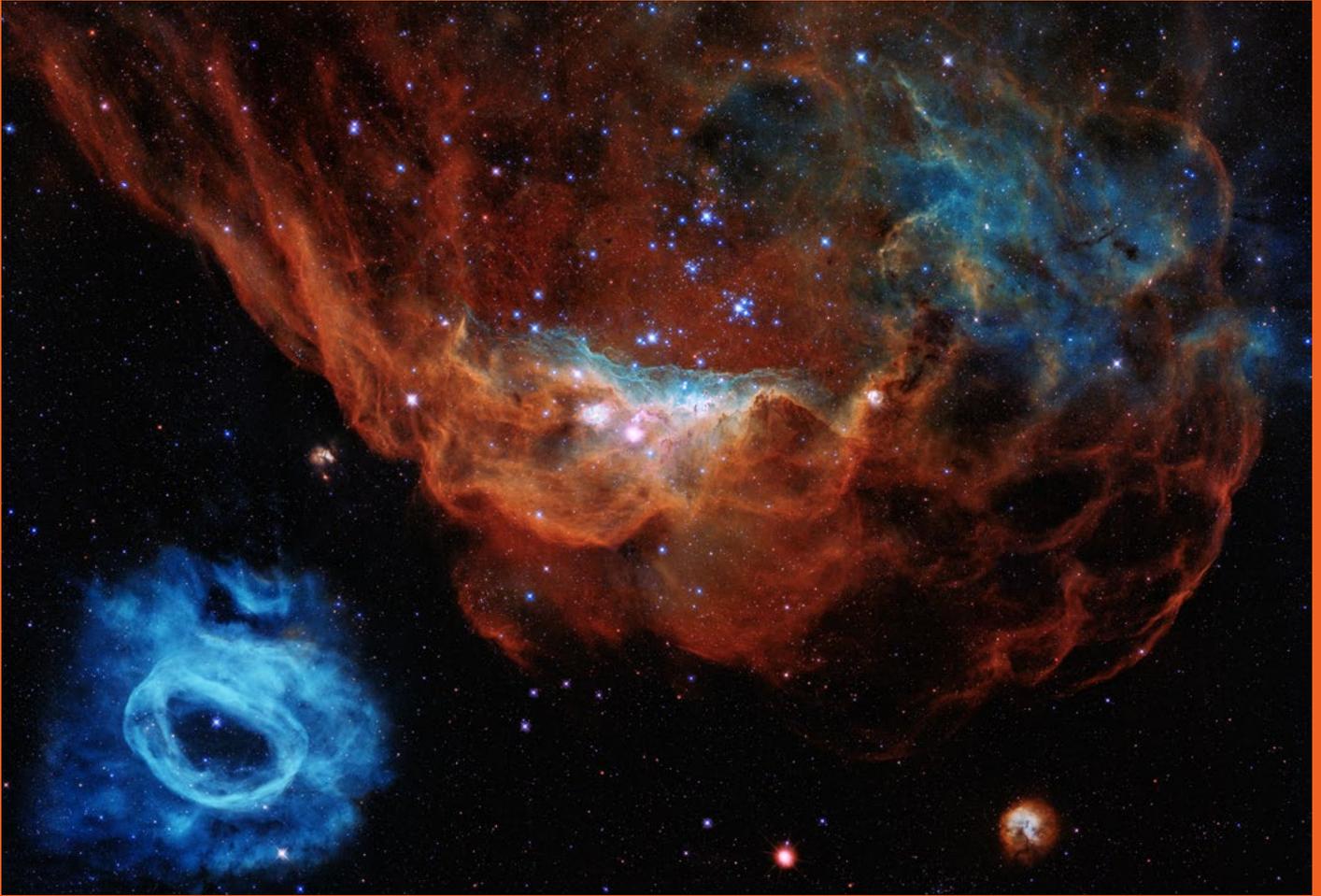
Hubblecast 127: 30 Years of Science with the Hubble Space Telescope

This video revisits some of Hubble's biggest science discoveries throughout its three decades of operation.



Hubblecast 128: Hubble's Collection of Anniversary Images

This Hubblecast looks back at the beauty and science behind each of the anniversary images unveiled as of 2005, including the very special 2020 Hubble Space Telescope 30th anniversary image.



24 April 13:00 Central European Time

Hubble Celebrates its 30th Anniversary with a Tapestry of Blazing Starbirth

24 April 2020 The NASA/ESA Hubble Space Telescope's iconic images and scientific breakthroughs have redefined our view of the Universe. To commemorate three decades of scientific discoveries, this image is one of the most photogenic examples of the many turbulent stellar nurseries the telescope has observed during its 30-year lifetime. The portrait features the giant nebula NGC 2014 and its neighbour NGC 2020 which together form part of a vast star-forming region in the Large Magellanic Cloud, a satellite galaxy of the Milky Way, approximately 163 000 light-years away. The image is nicknamed the "Cosmic Reef" because it resembles an undersea world.

On 24 April 1990 the Hubble Space Telescope was launched aboard the space shuttle Discovery, along with a five-astronaut crew. Deployed into low-Earth orbit a day later, the telescope has since opened a new eye onto the cosmos that has been transformative for our civilization.

Hubble is revolutionising modern astronomy not only for astronomers, but also by taking the public on a wondrous journey of exploration and discovery. Hubble's seemingly never-ending, breathtaking celestial snapshots provide a visual shorthand for its exemplary scientific achievements. Unlike any other telescope before it, Hubble has made astronomy relevant, engaging, and accessible for people of all ages. The mission

has yielded to date 1.4 million observations and provided data that astronomers around the world have used to write more than 17 000 peer-reviewed scientific publications, making it one of the most prolific space observatories in history. Its rich data archive alone will fuel future astronomy research for generations to come.

Each year, the NASA/ESA Hubble Space Telescope dedicates a small portion of its precious observing time to taking a special anniversary image, showcasing particularly beautiful and meaningful objects. These images continue to challenge scientists with exciting new surprises and to fascinate the public with ever more evocative observations.

This year, Hubble is celebrating this new milestone with a portrait of two colourful nebulae that reveals how energetic, massive stars sculpt their homes of gas and dust. Although NGC 2014 and NGC 2020 appear to be separate in this visible-light image, they are actually part of one giant star formation complex. The star-forming regions seen here are dominated by the glow of stars at least 10 times more massive than our Sun. These stars have short lives of only a few million years, compared to the 10-billion-year lifetime of our Sun.

The sparkling centerpiece of NGC 2014 is a grouping of bright, hefty stars near the centre of the image that has blown away its cocoon of hydrogen gas (coloured red) and dust in which it was born. A torrent of ultraviolet radiation from the star cluster is illuminating the landscape around it. These massive stars also unleash fierce winds that are eroding the gas cloud above and to the right of them. The gas in these areas is less dense, making it easier for the stellar winds to blast through them, creating bubble-like structures reminiscent of brain coral, that have earned the nebula the nickname the “Brain Coral.”

By contrast, the blue-coloured nebula below NGC 2014 has been shaped by one mammoth star that is roughly 200 000 times more luminous than our Sun. It is an example of a rare class of stars called Wolf-Rayet stars. They are thought to be the descendants of the most massive stars. Wolf-Rayet stars are very luminous and have a high rate of mass loss through powerful winds. The star in the Hubble image is 15 times more massive than the Sun and is unleashing powerful winds, which have cleared out the area around it. It has ejected its outer layers of gas, sweeping them around into a cone-like shape, and exposing its searing hot core. The behemoth appears offset from the centre because the telescope is viewing the cone from a slightly tilted angle. In a few million years, the star might become a supernova. The brilliant blue colour of the nebula comes from oxygen gas that is heated to roughly 11 000 degrees Celsius, which is much hotter than the hydrogen gas surrounding it.

Stars, both big and small, are born when clouds of dust and gas collapse because of gravity. As more and more material falls onto the forming star, it finally becomes hot and dense enough at its centre to trigger the nuclear fusion reactions that make stars, including our Sun, shine. Massive stars make up only a few percent of the billions of stars in our Universe. Yet they play a crucial role in shaping our Universe, through stellar winds, supernova explosions, and the production of heavy elements.

“The Hubble Space Telescope has shaped the imagination of truly a whole generation, inspiring not only scientists, but almost everybody,” said Günther Hasinger, Director of Science for the European Space Agency. “It is paramount for the excellent and long-lasting cooperation between NASA and ESA.”

More information

The Hubble Space Telescope is a project of international cooperation between ESA and NASA.

This image was taken with the Telescope’s Wide Field Camera 3.

Image Credit: NASA, ESA, and STScI

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