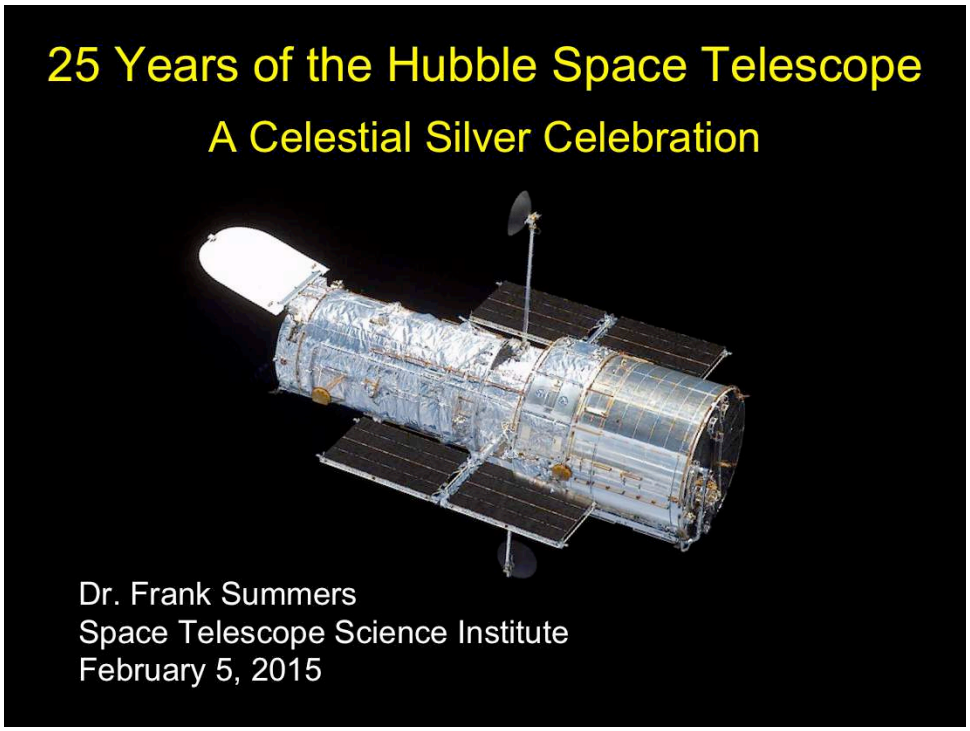
Notes to Presenters

- These slides are from a presentation by Dr. Frank Summers of the Space Telescope Science Institute in February 2015.
- This presentation features one Hubble image from each year of operation. This set is not meant to represent the most significant, most beautiful, or most anything. They are ones that illustrate the breadth and depth of Hubble observations, as well as the stories the speaker wanted to tell. Please adjust or augment as you see fit.

Notes to Presenters 2

- Images are predominantly public domain NASA images or unrestricted images from wikimedia commons. However, strict copyright checking has not been done.
- See further notes on each slide. Slide notes, written by Dr. Summers, explain the basic ideas of each slide's graphics.
- A longer, and slightly different, version of this talk is available to watch on YouTube:
  - https://www.youtube.com/watch?v=8vpHrCtdDtA

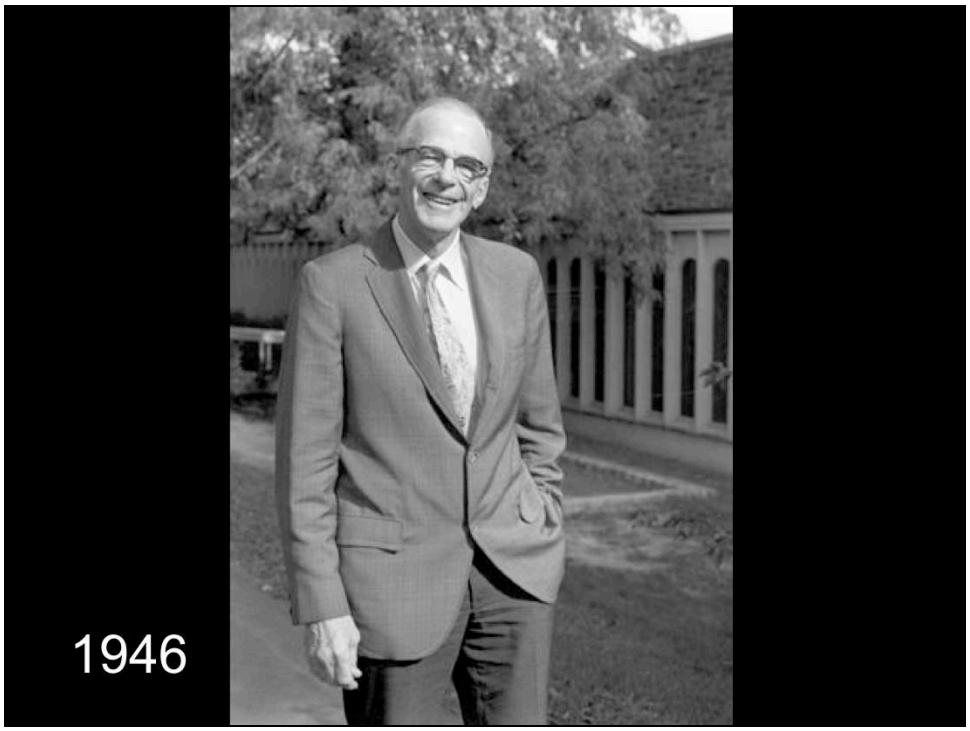


Title Slide

Be sure to change the presentation information in the lower left.

Change the title and subtitle as you wish.

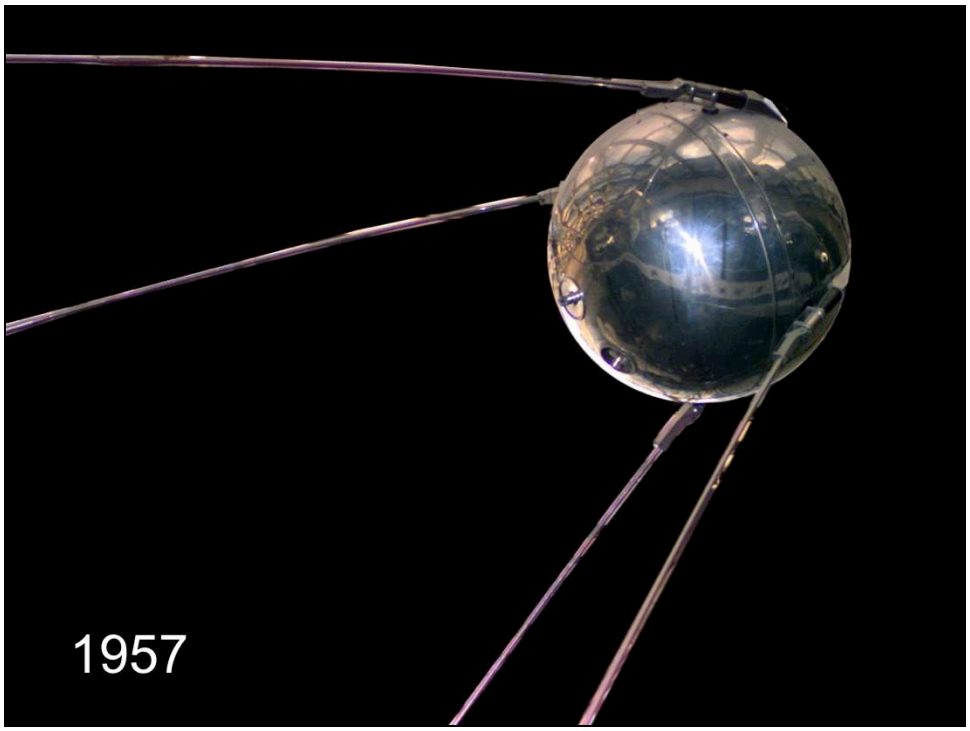
Hubble Space Telescope after Servicing Mission 3B (2003)



In 1946, while working for the RAND Corporation, Lyman Spitzer wrote a white paper about the benefits of putting a telescope into space. The major benefit is that getting above the blurring effects of Earth's atmosphere provides a clearer view.

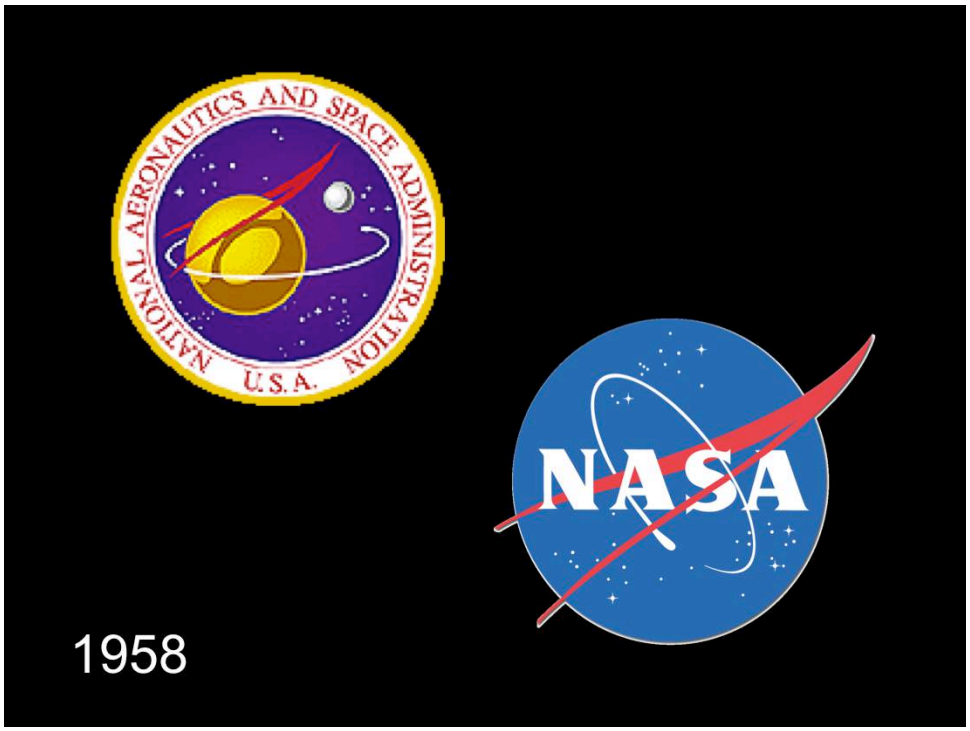
Note that 1946 is before the start of the space age. Even before we had the capacity to do so, astronomers were dreaming of space telescopes.

This image of Lyman Spitzer was taken decades later at Princeton University.



The space age began with the launch of Sputnik 1 on October 4, 1957. The world's first human-made satellite was about the size of a beachball (23 cm diameter) and emitted a radio signal that announced its presence in orbit around the globe.

This picture is a model of Sputnik from a museum.



One year later, the United States established the National Aeronautics and Space Administration. NASA began operations on October 1, 1958.

The upper left image is NASA's original logo, while the lower right image is NASA's current logo.

A 1962 study by the National Academies of Sciences recommended that a space telescope become one of the US national science priorities. This report spawned numerous groups to develop ideas for the observatory and its scientific instruments, not just in the US, but also around the world.

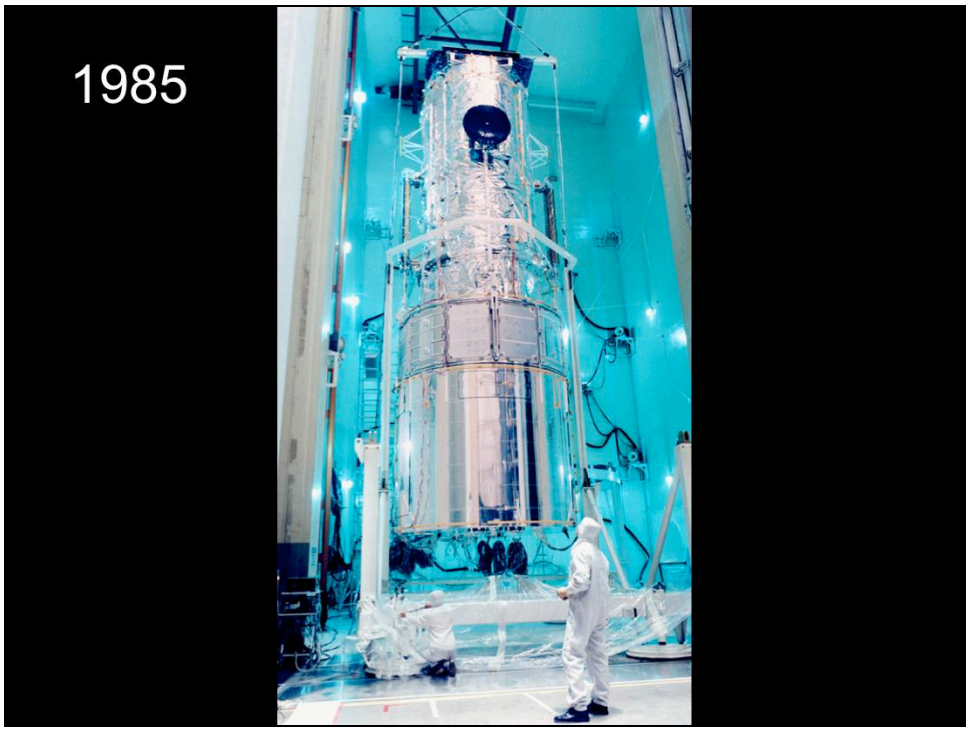
The main image shows the NAS building in Washington, DC. The inset image is a sculpture of Albert Einstein outside the NAS building.

In 1976, NASA and ESA, the European Space Agency, joined their space telescope proposals. This collaboration helped provide broader support for the project and helped spread the considerable financial responsibility.

The upper left image is the NASA logo from that time (often nicknamed the “worm” logo). The bottom right image is ESA’s current logo.

In 1977, The US Congress funded what was then known as the Large Space Telescope project.

The image is of the US Capitol Building in Washington, DC.

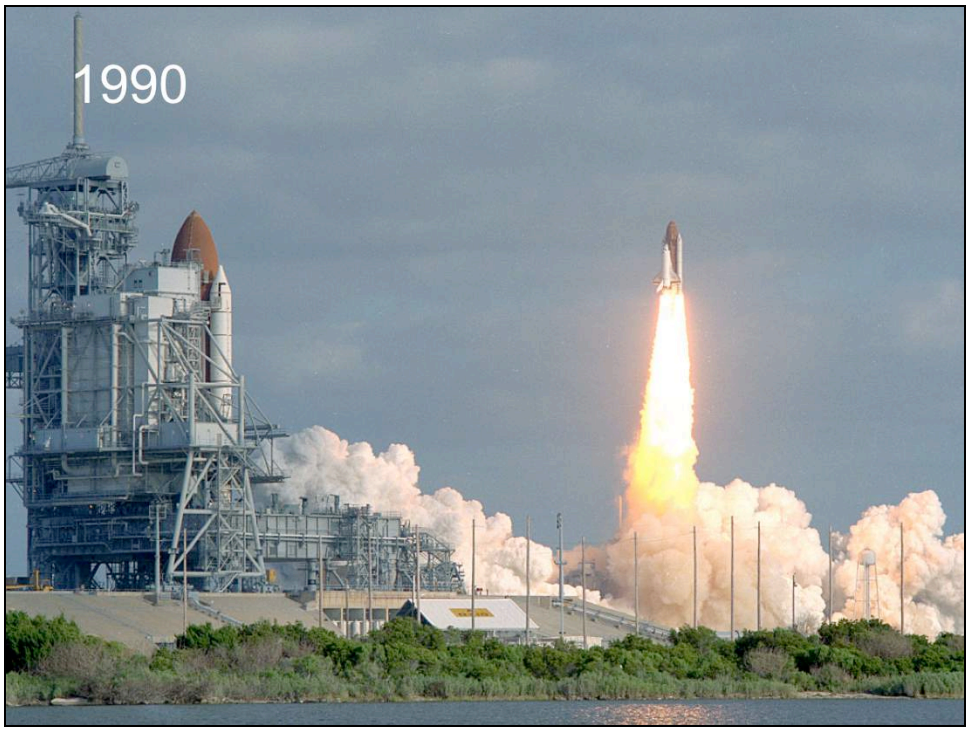


Construction of the telescope moved relatively swiftly, reaching completion in 1985. The Hubble Space Telescope was built, tested, and ready for launch aboard the Space Shuttle.

The image shows the Hubble Space Telescope during testing. The workers in their clean room suits provide scale for the 40 foot tall telescope.

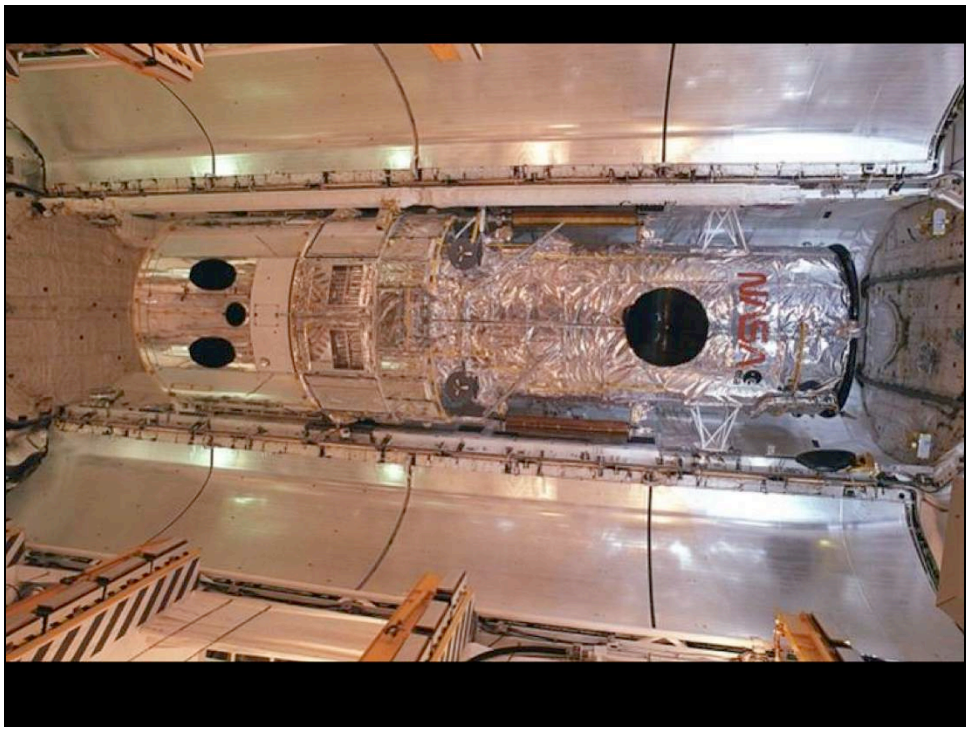
The Challenger accident in 1986 halted the Space Shuttle program and put the space telescope project on hold.

The image shows the clouds and debris resulting from the explosion of the Space Shuttle Challenger shortly after launch on January 28, 1986.



After the Space Shuttle program resumed, the Hubble Space Telescope was launched aboard the Space Shuttle Discovery on April 24, 1990.

The image shows the launch of STS-31 from launchpad 39B. The Space Shuttle Columbia sits at Launchpad 39A in the foreground.



One constraint on the Hubble Space Telescope's design was that it must fit into the Space Shuttle cargo bay.

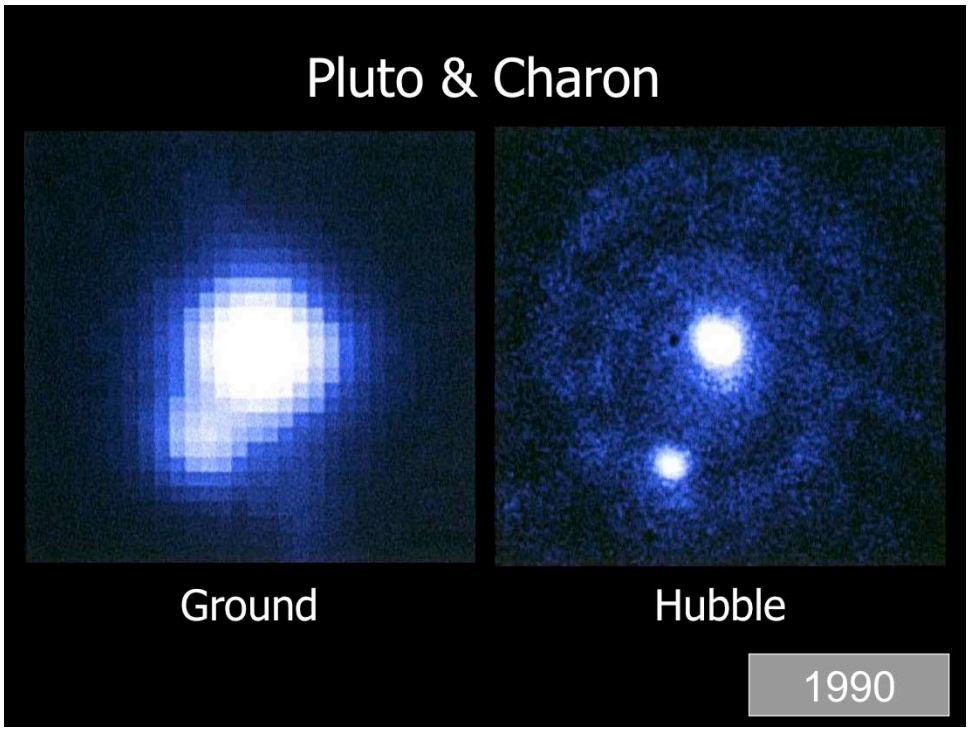
This image shows HST in Discovery's cargo bay before launch.

On April 25, 1990, the Hubble Space Telescope was deployed into low-Earth orbit by the crew of STS-31.

This image, from an IMAX camera in the cargo bay, captures that moment of deployment.

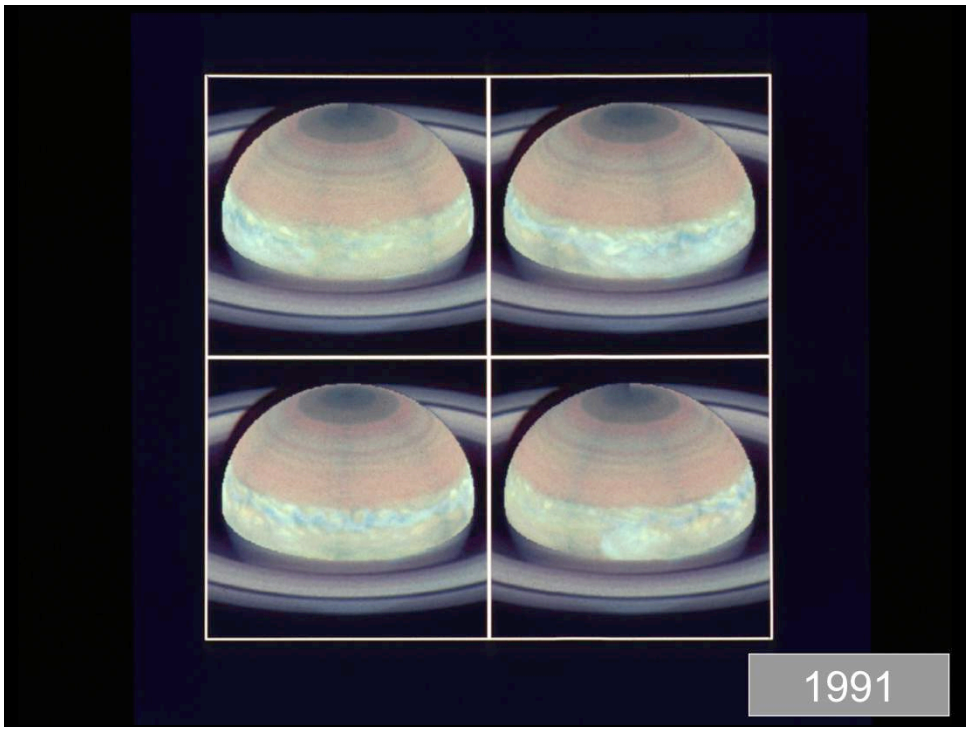
During initial testing of Hubble's optics, a flaw was found. The mirror had been ground to the wrong shape and the images returned were slightly out of focus. The problem was not in the design, but that the testing apparatus was out of alignment, causing the mirror to be ground to a slightly wrong shape. The media soundly took NASA to task for its very public error.

The image on the left is the cover of Newsweek, showing that the mainstream media took this seriously. On the top right is a cartoon comparing Hubble to the famously poor-sighted Mr. Magoo. The bottom right cartoon shows Hubble and an eye chart, although the artist has Hubble pointing the wrong way to read the chart. Note that this last cartoon is from 2009, during Servicing Mission 4, and is intended to support the servicing of Hubble. However, the message it sends, and the scarcity of finding cartoons from the early 1990s, warranted its inclusion here. Purists may want to delete it.



As an example of both Hubble's strengths and flaws, examine these comparison images of Pluto and Charon. From the ground, the two objects appear much larger and a bit blended together. Hubble's resolution clearly separates them. The extra scattered light around the images is indicative of the mirror flaw. While Hubble could not achieve its design specifications, it was still significantly better than ground-based telescopes.

http://hubblesite.org/newscenter/archive/releases/1990/14/



In 1991, Hubble captured a rare event on Saturn, a storm that grew to encircle the planet. The previous storm of this magnitude occurred in 1933.

While Hubble's views not as good as those from missions that visit the planets, its value for providing high-resolution, long-term monitoring of solar system events has been proven over and over again.

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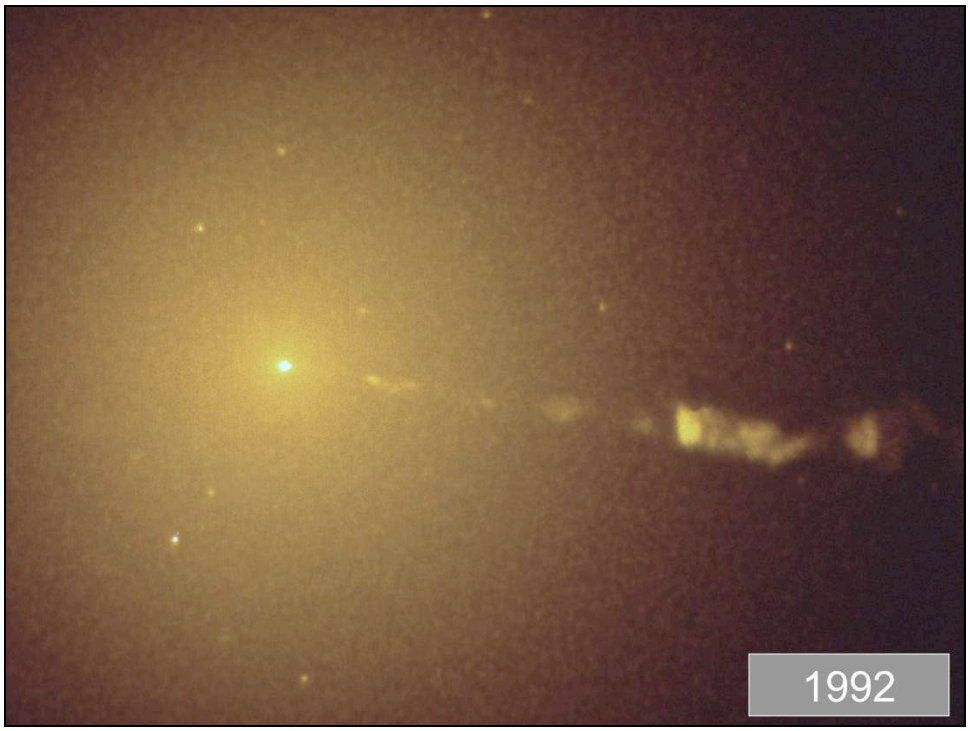

Messier 87 is a giant elliptical galaxy at the heart of the Virgo Cluster of galaxies. Emanating from M87's core is a long jet of energetic charged particles.

Hubble's keen resolution helped resolve the core of the galaxy, and provided strong evidence of a supermassive black hole (2.6 billion solar masses) at the center of the galaxy and as the source of the jet.

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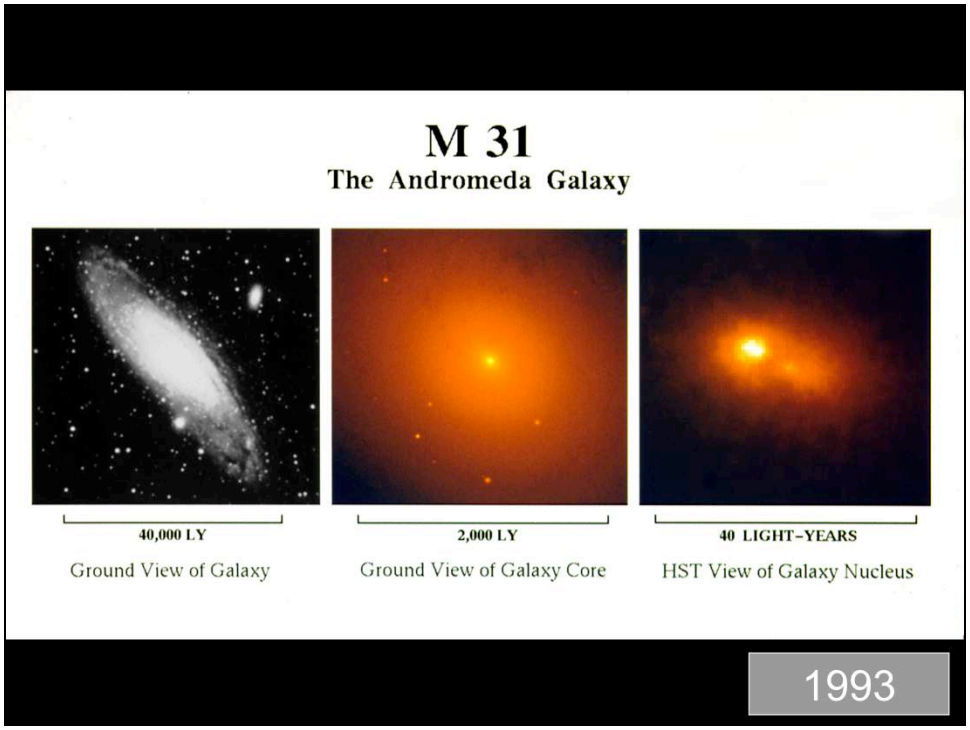

The nearest large galaxyto our Milky Way Galaxy is the Andromeda Galaxy. The ground-based images here show a wide-field view of the galaxy on the left, and a close-up of the central region in the center.

Hubble's view of the core, on the right, revealed two bright sources: a double nucleus. The brighter source was previously thought to be the galaxy's center, but was revealed to be several light-years away from the true center, located at the dimmer source.

Again, Hubble's resolution, even with the mirror flaw, provided cutting-edge science results not possible from the ground.

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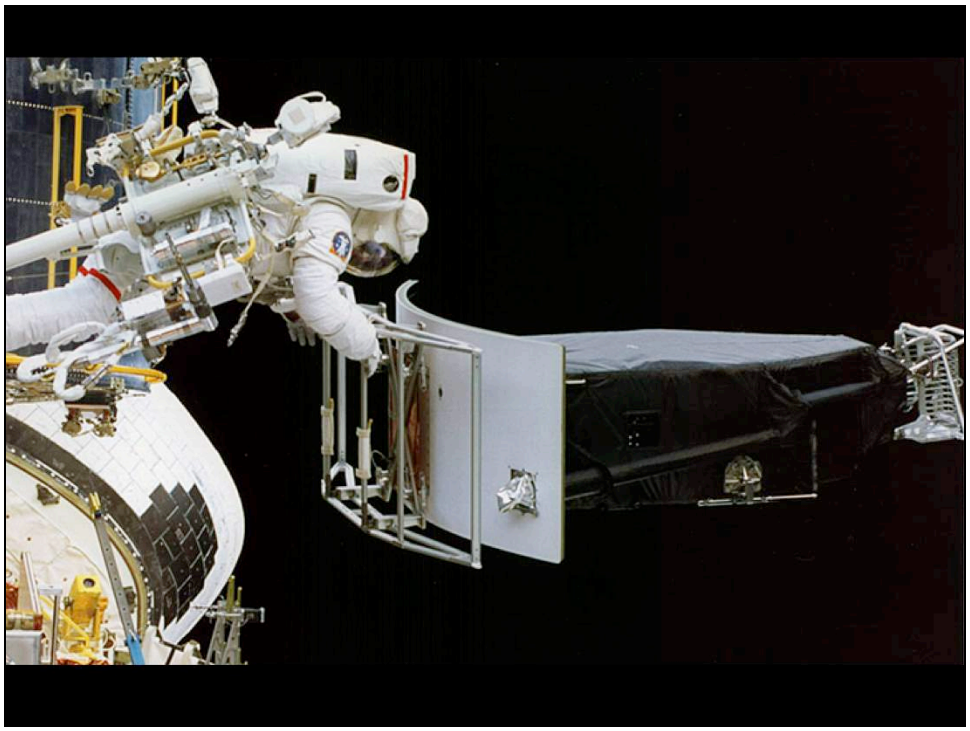
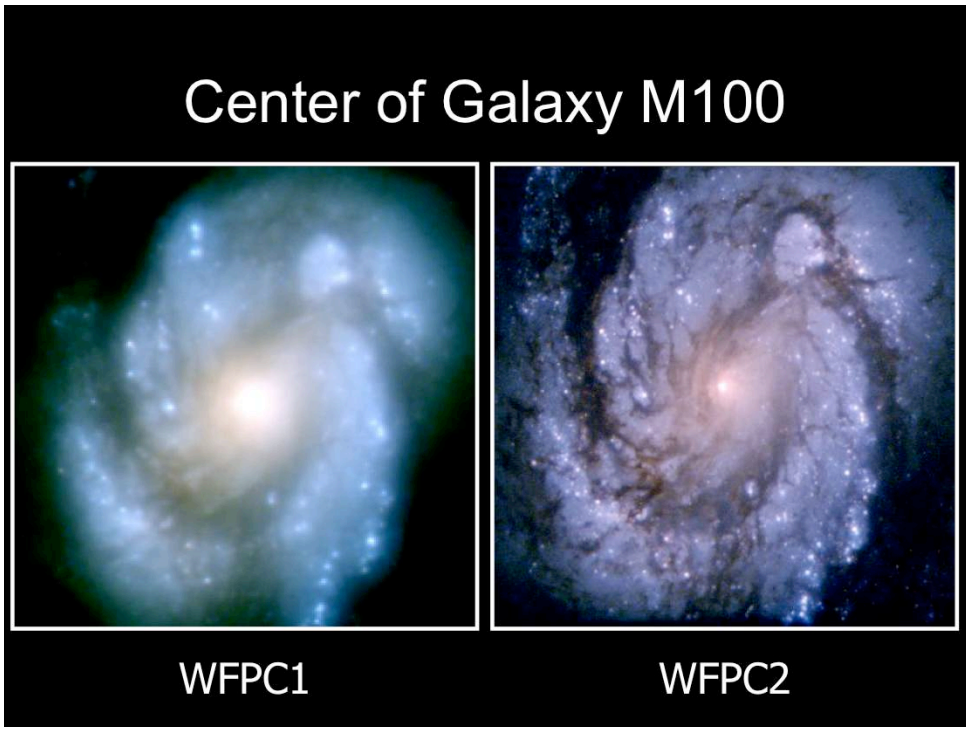


Servicing Mission 1 (STS-61, Space Shuttle Endeavor) took place in December 1993. Astronauts installed COSTAR (Corrective Optics Space Talescope Axial Replacement) which provided optics to correct the mirror flaw for most of the instruments. The other instrument, WFPC1 (Wide-Field Planetary Camera 1), was replaced by WFPC2, which had the correction built into its optics.

The image shows astronauts replacing WFPC1 with WFPC2.



These two images of center of galaxy Messier 100, from WFPC1 and WFPC2, show how well Servicing Mission 1 corrected the mirror flaw. Hubble could now achieve its design specifications.

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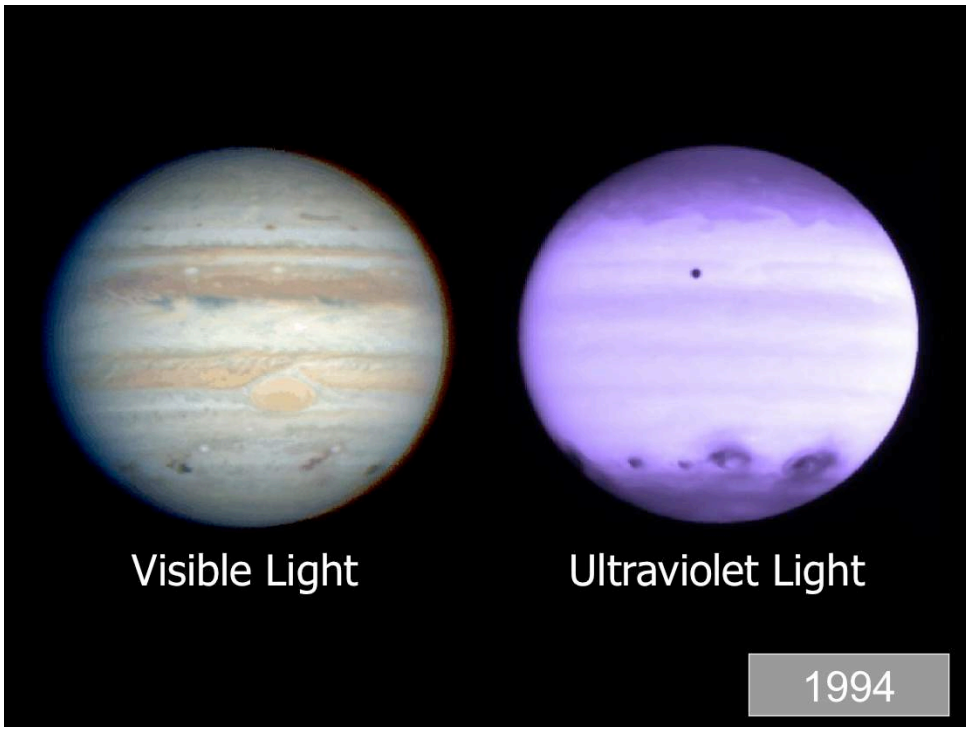

The fix to Hubble's mirror cam in time to witness a spectacular event: comet Shoemaker-Levy 9 slamming into Jupiter in July 1994.

The comet broke into more than two dozen pieces, and those pieces created huge impact sites, visible as the dark spots along the lower part of the visible light image.

These impact sites are even more apparent in Hubble's ultraviolet light image. Because most ultraviolet light is absorbed by Earth's atmosphere, ultraviolet astronomy is only possible from space missions.

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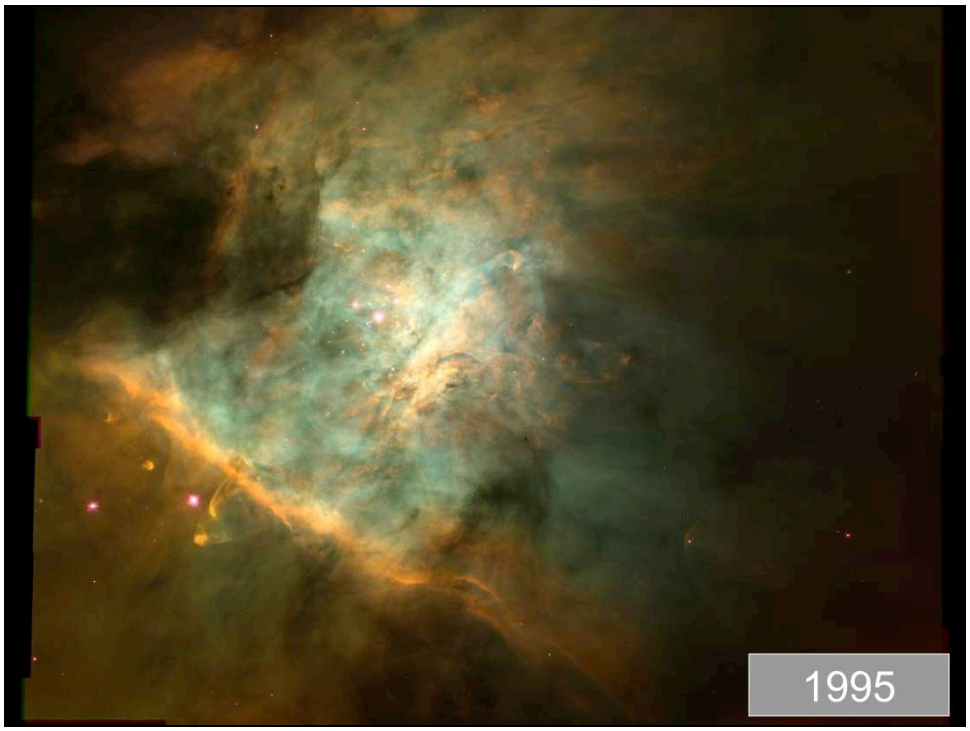

Hubble turned it keen eye toward the rich, nearby, star forming region of the Orion Nebula. This mosaic of observations revealed new details of the nebula and of star birth.

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http://hubblesite.org/newscenter/archive/releases/1995/45/

Among the amazing details uncovered are the bow shock around LL Orionis (left inset). The strong stellar winds from the hot newborn stars blow across the nebula, and in this case create a bow shock of gas that resembles the wake pattern at the front of a ship moving across a calm ocean.

In the top right image, the bow shock has wrapped entirely around the object and creates a windsock or tadpole shape. These objects are nicknamed “proplyds”, a contraction of “proto-planetary disks”.

The bottom center image shows a newborn star and its dark proto-plaentary disk wrapped around it. Within this disk planets are forming. Hubble has shown us solar systems in the making.

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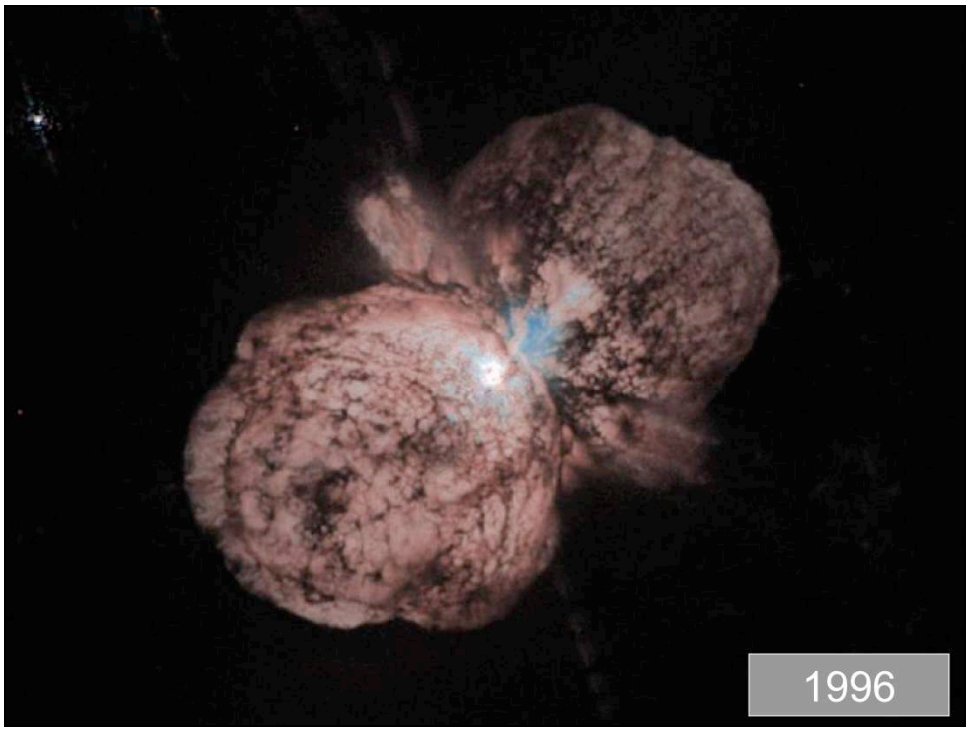

The star Eta Carinae is estimated to be about 100 times more massive than our Sun. Such heavyweight stars live relatively short lives (millions of years, compared to billions of years for our Sun) and die in supernova explosions.

Hubble revealed the details of material being ejected from the dying star during its pre-supernova phase. Two huge bubbles of gas are being blown out in an hourglass shape.

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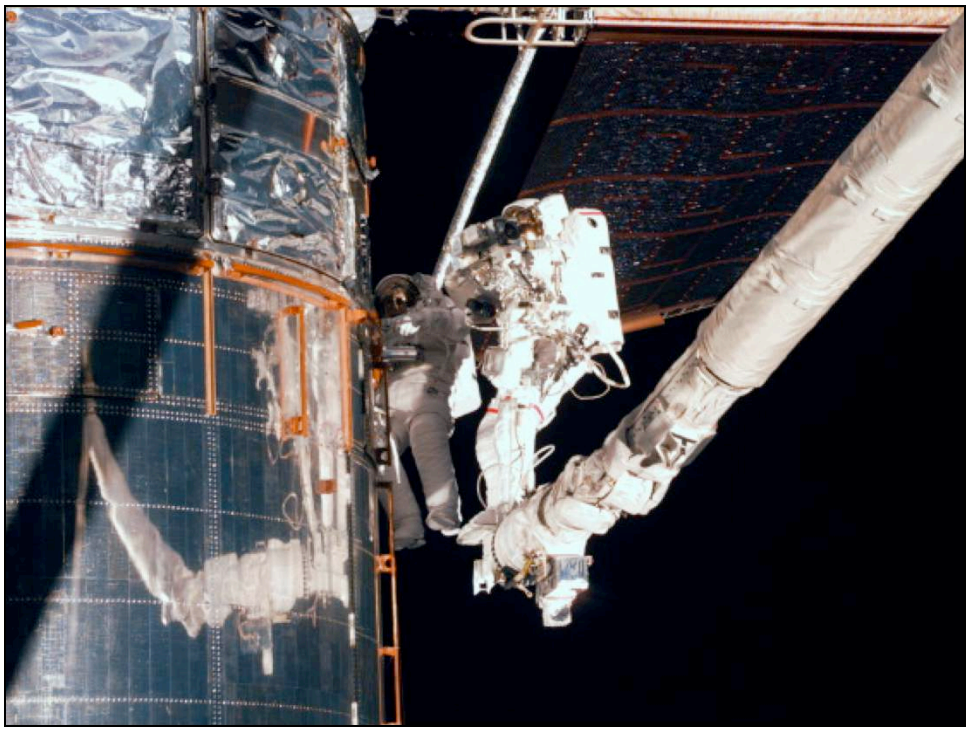
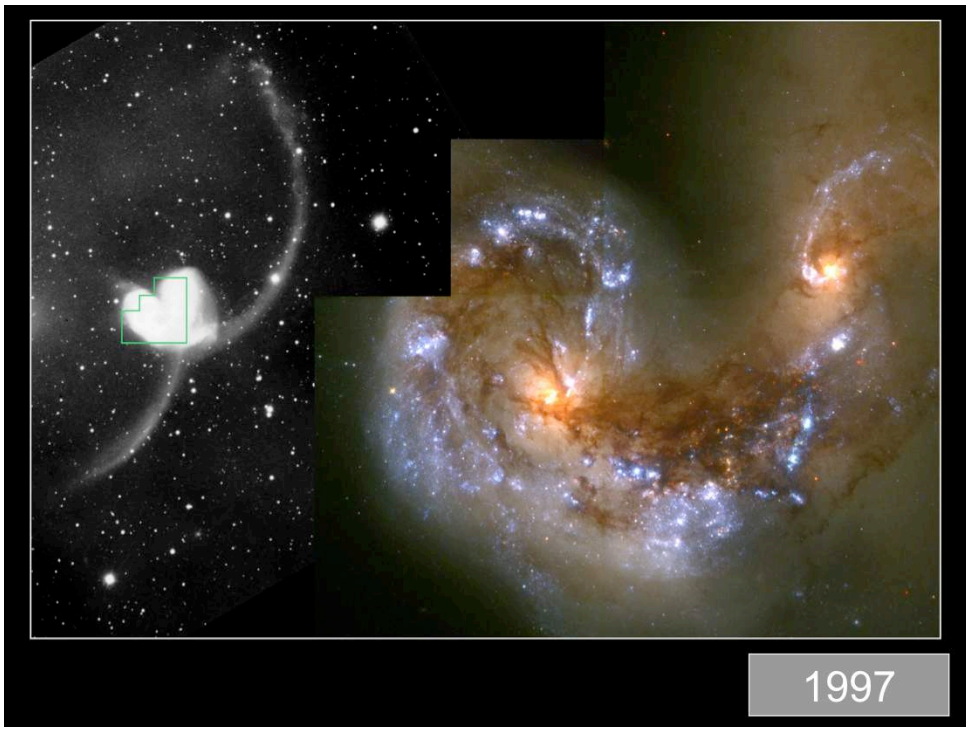


Hubble Servicing Mission 2 (STS-82, Space Shuttle Discovery) took place in February 1997. The astronauts installed the Space Telescope Imaging Spectrograph (STIS) and the Near-Infrared Camera / Multi-Object Spectrograph (NICMOS). As their names imply, both instruments improved Hubble's ability to take spectra of cosmic objects. However, each instrument can also take images, improving the ultraviolet (STIS) and infrared (NICMOS) performance and capabilities of the observatory.



The Antennae Galaxies are a well-known pair of interacting galaxies named for the long tidal tails stretching away from the core.

Hubble's view of the core of the Antennae revealed the tremendous amount of star formation induced by the interaction. The bright blue regions in the image are regions of intense star formation and feature "super star clusters" larger than had previously been observed in such galaxy collisions.

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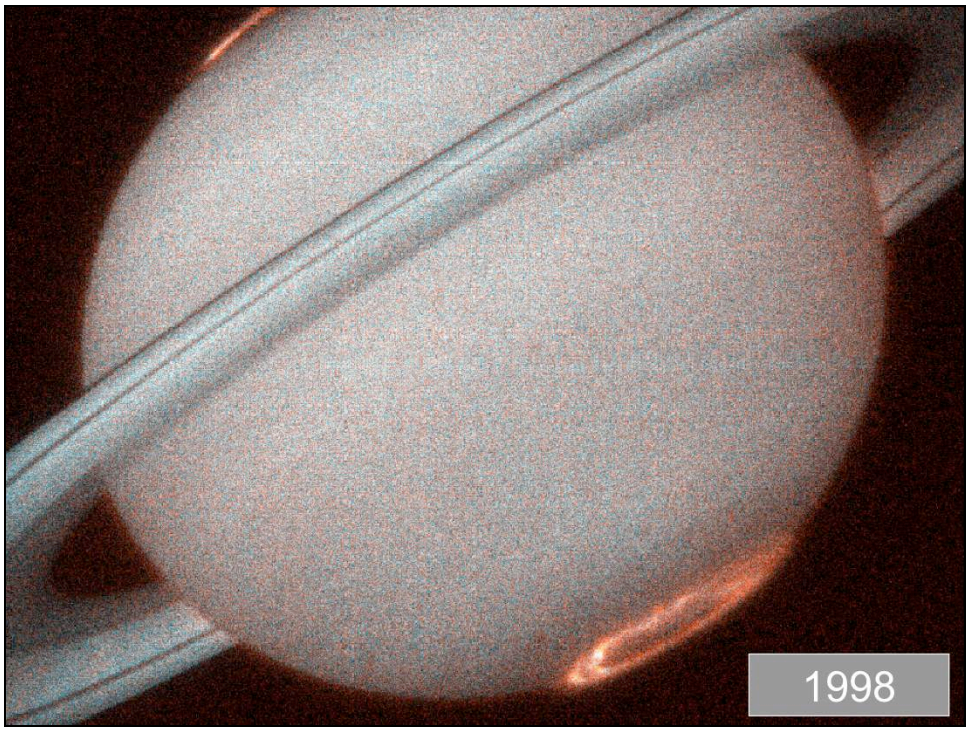

Like Earth, Saturn has aurora at both poles. However, while Earth's aurora are visible to the human eye, Saturn's aurora are viewable only in ultraviolet light (hence only from space).

Hubble has been able to observe and monitor Saturn's aurorae, revealing their patterns and changes.

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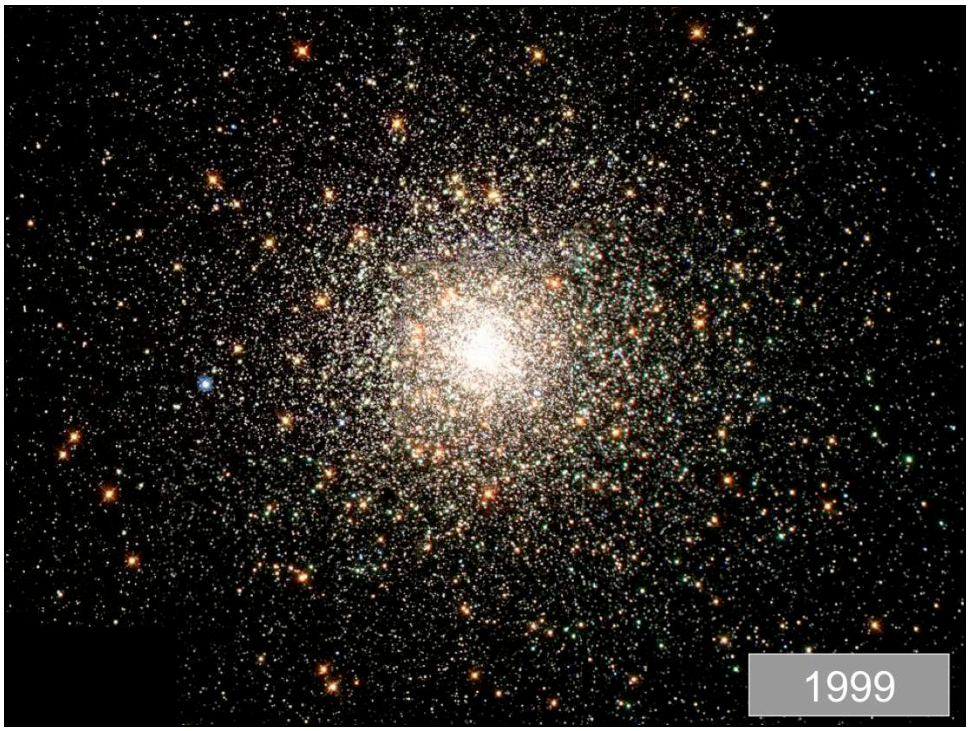
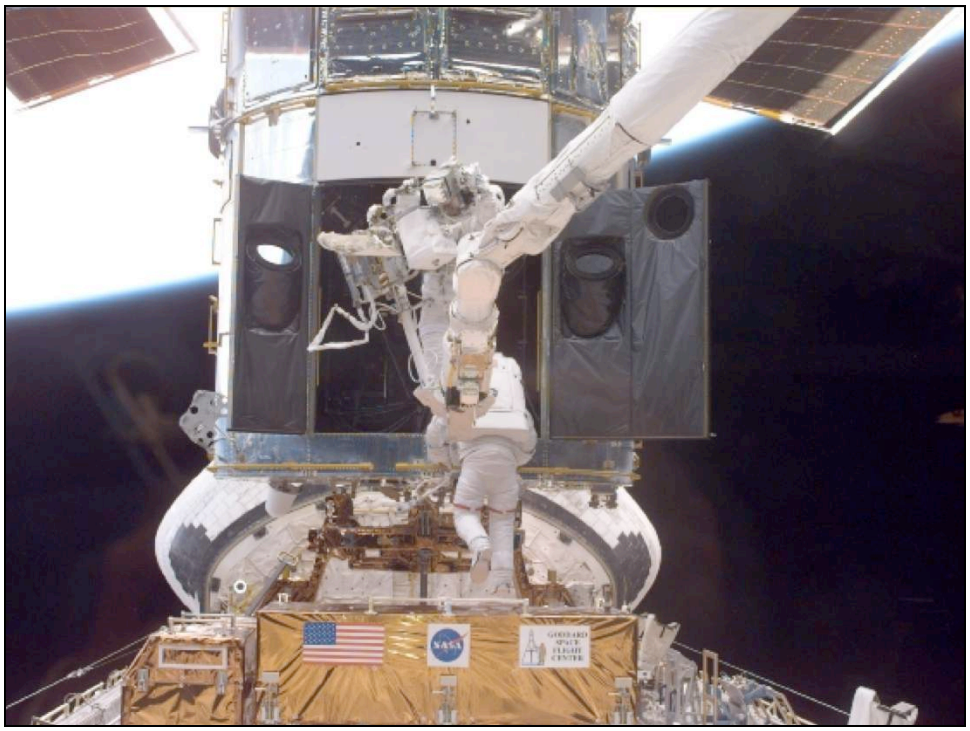


The globular star cluster Messier 80 is an ancient swarm of hundreds of thousands of stars. Hubble's resolution is necessary to see the details of the cores of these globular clusters. Observations have revealed a population of "blue straggler" stars, unexpectedly massive stars believed to have formed by the rare collisions of stars only possible in these dense cores.

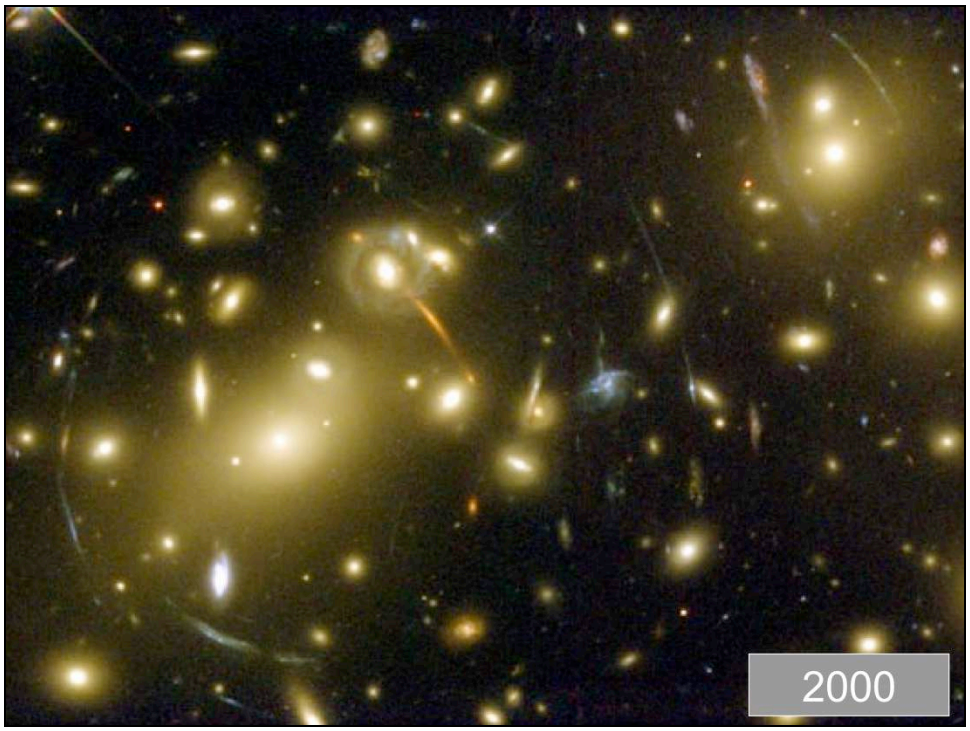
http://hubblesite.org/newscenter/archive/releases/1999/26/



Hubble has six gyroscopes and requires three of them in joint operation to control the pointing of the telescope. However, the gyroscopes have limited lifetimes.

When a third gyroscope failed in 1999, NASA moved up part of Servicing Mission 3 from mid-2000 to December 1999. The mission, now called Servicing Mission 3A, became critical when a fourth gyroscope failed in November 1999. Hubble was placed into safe mode, ceasing science operations until the repair mission was launched.

SM3A (STS-103, Space Shuttle Discovery) replaced the gyroscopes, installed a much faster onboard computer, and performed other maintenance work on Hubble, but did not change its science instruments.



As part of the press release announcing that Hubble had returned to science operations after SM3A, NASA released this color image of the galaxy cluster Abell 2218 (a similar black and white image had been released in 1995).

Abell 2218 contains so many galaxies and so much mass that Einstein's General Relativity comes into play. The basics of General Relativity is that mass warps space.The mass of this galaxy cluster warps space strongly enough that images of more distant galaxies are distorted and stretched when passing through the warped space.

This "gravitational lensing" produces the circular arcs and streaks seen throughout this galaxy cluster. Hubble's resolution allows astronomers to observe and to characterize these lensed galaxies more clearly than before.

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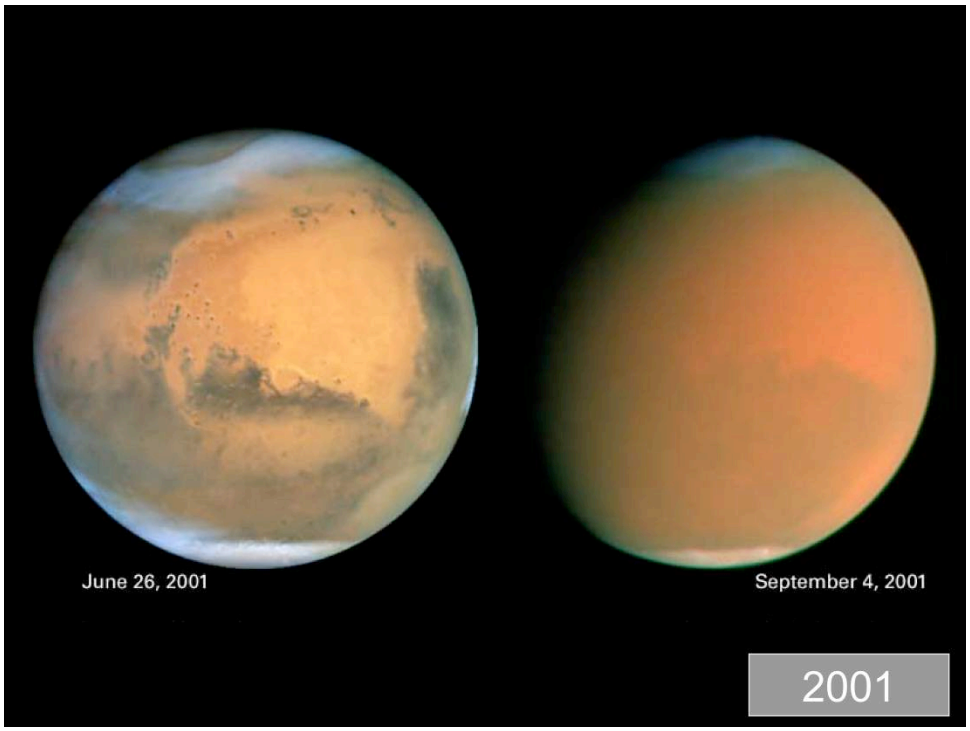

In June of 2001, Mars approached closer to Earth than it had ever been during Hubble's lifetime. Naturally, Hubble captured its highest resolution picture yet of the red planet.

Within the lower right of that image one can see a dust storm in the Hellas Basin, a giant impact crater on Mars. Over the ensuing months, that storm propagated into a series of dust storms that engulfed the entire planet. The September image shows one snapshot of the largest Martian global dust storm in decades.

These images are another example of the Hubble "Interplanetary Weather Channel" capability, providing decades of monitoring to capture long term changes and exceptional events across the solar system.

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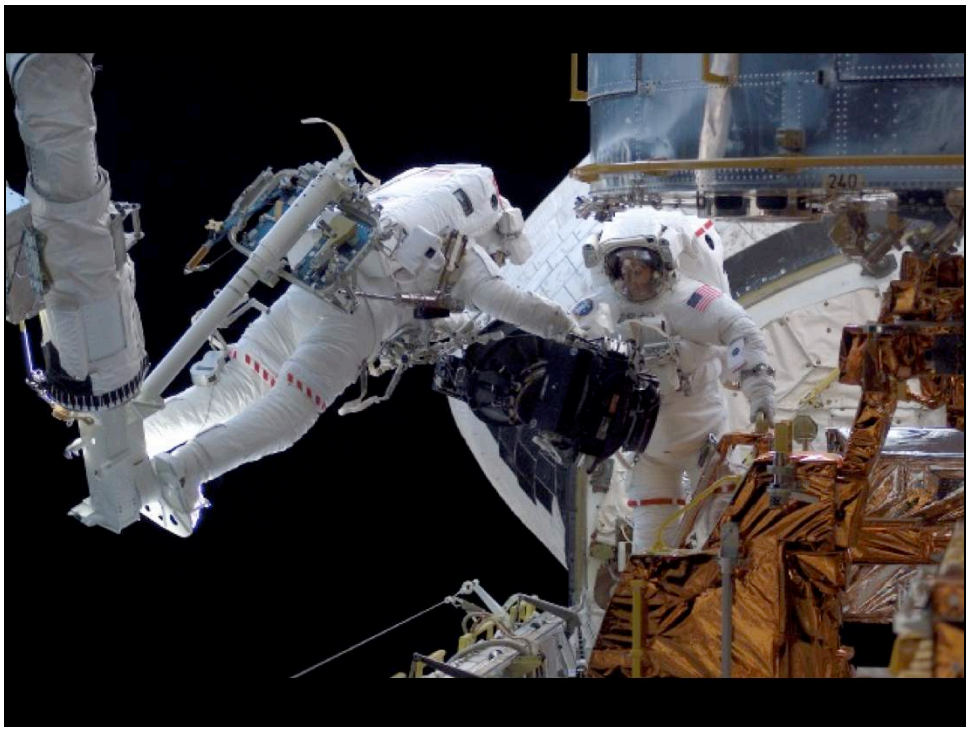
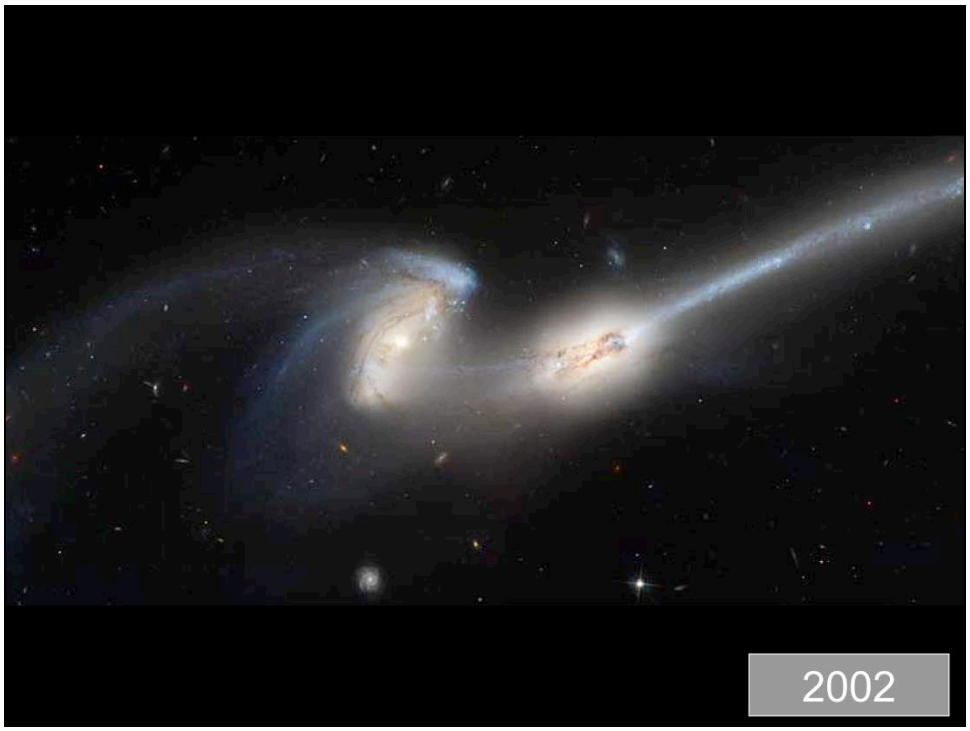
http://hubblesite.org/newscenter/archive/releases/2001/31/



Servicing Mission 3B (STS-109, Space Shuttle Columbia) took place in March 2002.

Although originally viewed as the second half of the planned Servicing Mission 3, the activities grew significantly beyond those parameters by the time of launch.

The most important task was the installation of the Advanced Camera for Surveys (ACS) as the new main camera, with its higher resolution, larger field of view, and improved sensitivity.



This pair of galaxies, nicknamed “The Mice”, are both crashing together and being pulled apart. The tidal forces of gravity pull out the long stream of stars and gas that forms the tails of the mice. The two dense centers will eventually merge and become one combined galaxy.

This Hubble image was released as part of the news story that, after SM3B, Hubble was back in business and better than ever.

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http://hubblesite.org/newscenter/archive/releases/2002/11/

The New York Times

WORLDCOM LEADER DEPARTS COMPANY IN TURBULENT TIME

PROBE PROFITS SQUELCH

Factors That Built Career and a Communications Giant Led to Their Downfall

NEW STRATEGY SET BY U.S. AND SAUDIS FOR MIDEAST CRISIS

Americans to Focus on Sharon as Arab Leaders Press Arafat

U.N. May Drop Inquiry at Jenin As Israel Resists

Postcards From the Edge

The press release announcing the first images from ACS garnered remarkable attention.

Four Hubble images were printed in the New York Times on the front page, above the fold, and in color – even though there were no science results announced, just the news that Hubble was back to science operations.

This attention demonstrates how deeply the public had come to respect, and even expect, the marvelous images and discoveries from Hubble.

http://hubblesite.org/newscenter/archive/releases/2002/11/

This image of the Sombrero Galaxy is one of the first large mosaics produced from the ACS instrument. Combining data from six pointings, the full resolution image contains over 70 million pixels.

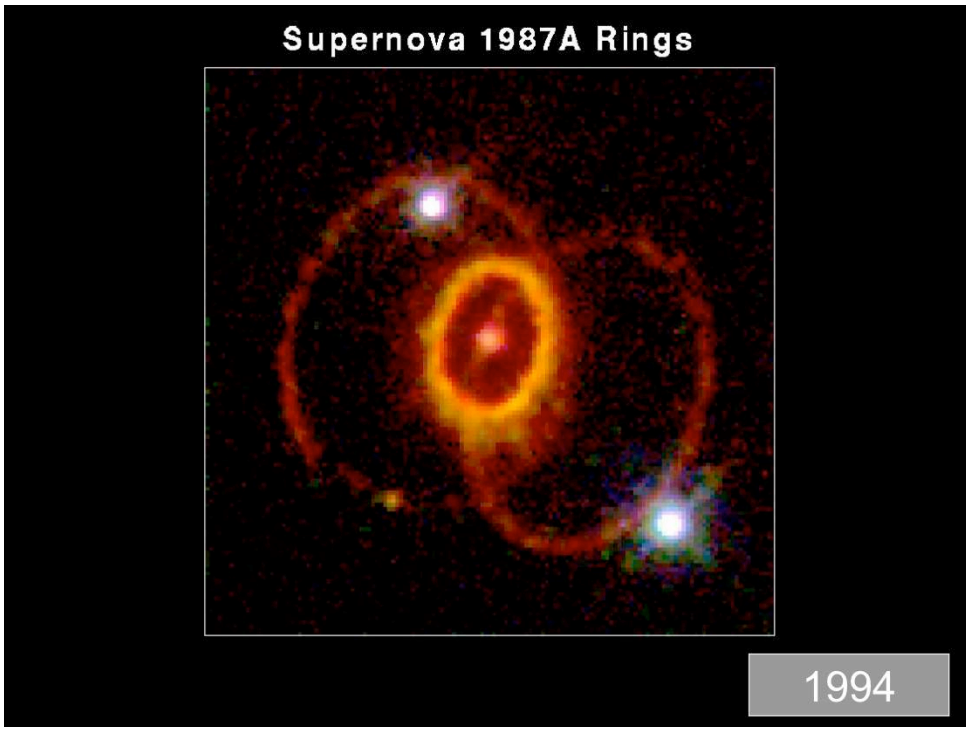
Note that all of Hubble's highest resolution press release images are available for download by the public through HubbleSite.org.

http://hubblesite.org/newscenter/archive/releases/2003/28/

This image shows the astronauts of SM3B with NASA Administrator Sean O'Keefe on the runway with the Space Shuttle Columbia after STS-109.

STS-109 was the last successful mission of Columbia, as its heat shielding failed catastrophically during re-entry on its next flight. Based on that disaster, NASA determined that shuttle missions required a back-up plan in case of damage during launch.

Shuttle missions to the International Space Station could continue, as astronauts could wait aboard station until a rescue mission was launched. With no such safe haven for a Hubble mission, Sean O'Keefe canceled the final Hubble Servicing Mission in January 2004.



Supernova 1987A is the closest observed supernova since the invention of the telescope. Hubble observed it early and often.

This image from 1994 shows the set of rings found to surround the central red supernova. The orange inner ring is material ejected in the pre-supernova phase and surrounds the exploded star.

The red outer rings are thought to be foreground and background gas, perhaps illuminated by a precessing jet during the star's life.

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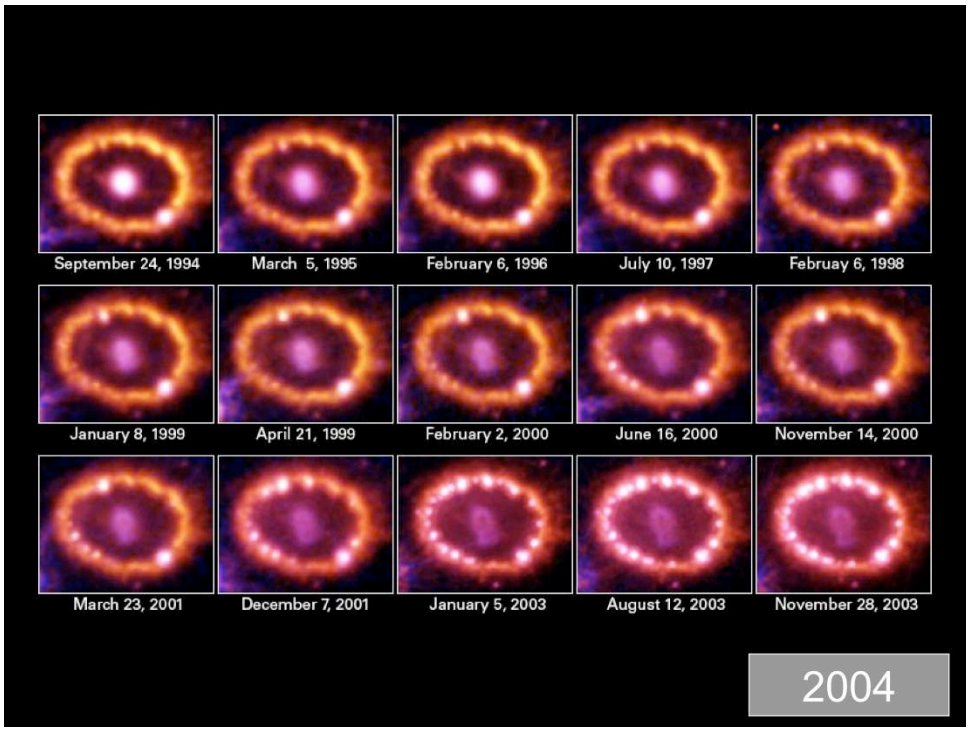
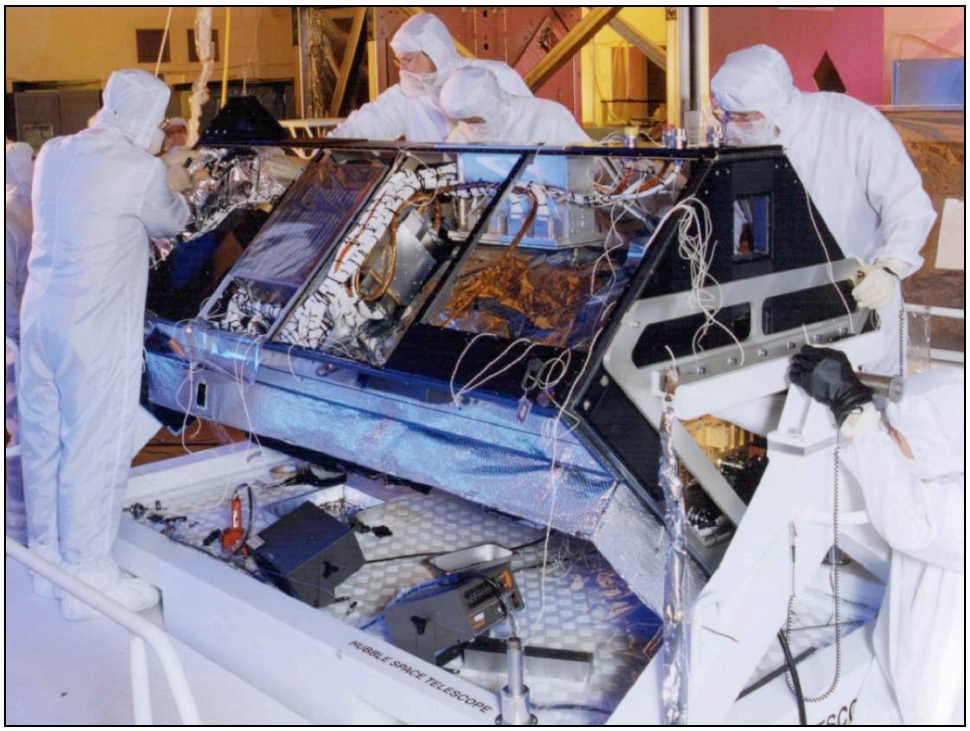


Hubble had a “ring-side seat” in following the development of SN 1987A.

As the shock wave from the explosion expands outward and impacts the inner ring, the clouds within the ring light up.

In addition, the central cloud of the supernova remnant expands and fades.

http://hubblesite.org/newscenter/archive/releases/2004/09/

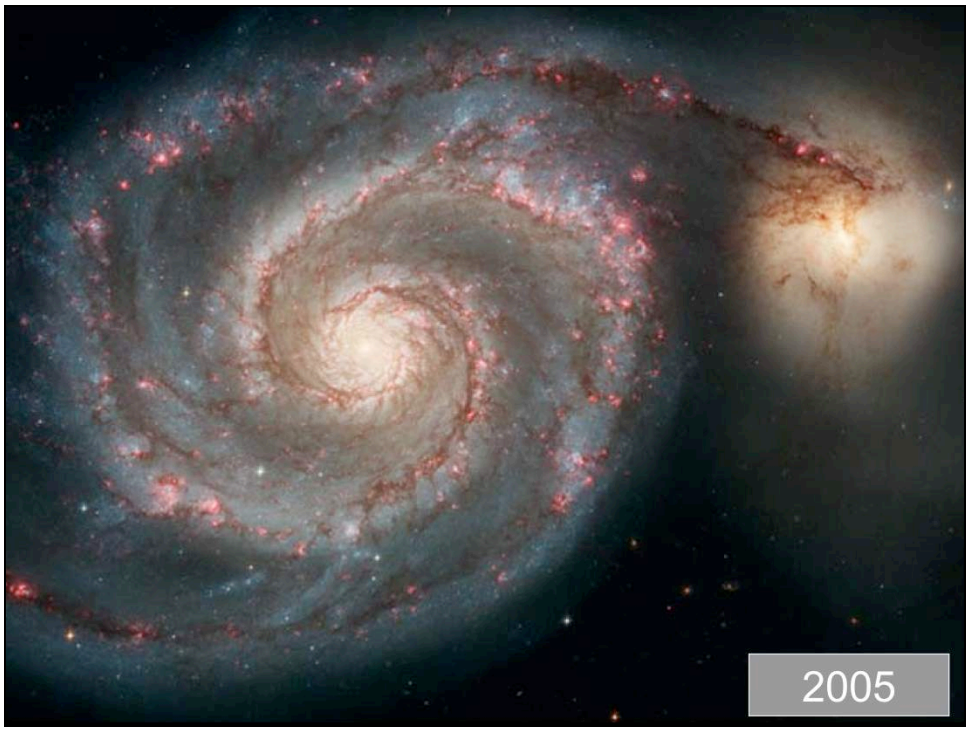


In mid-2004, Hubble's STIS instrument suffered a failure that took it out of service.

The observatory's instruments were built with two sets of redundant electronics. STIS Side 1 electronics had failed in May 2001, and Side 2 suffered a power supply failure in August 2004.

Without STIS, Hubble's primary ultraviolet observing capability was removed, and, without a final servicing mission, could not be restored.

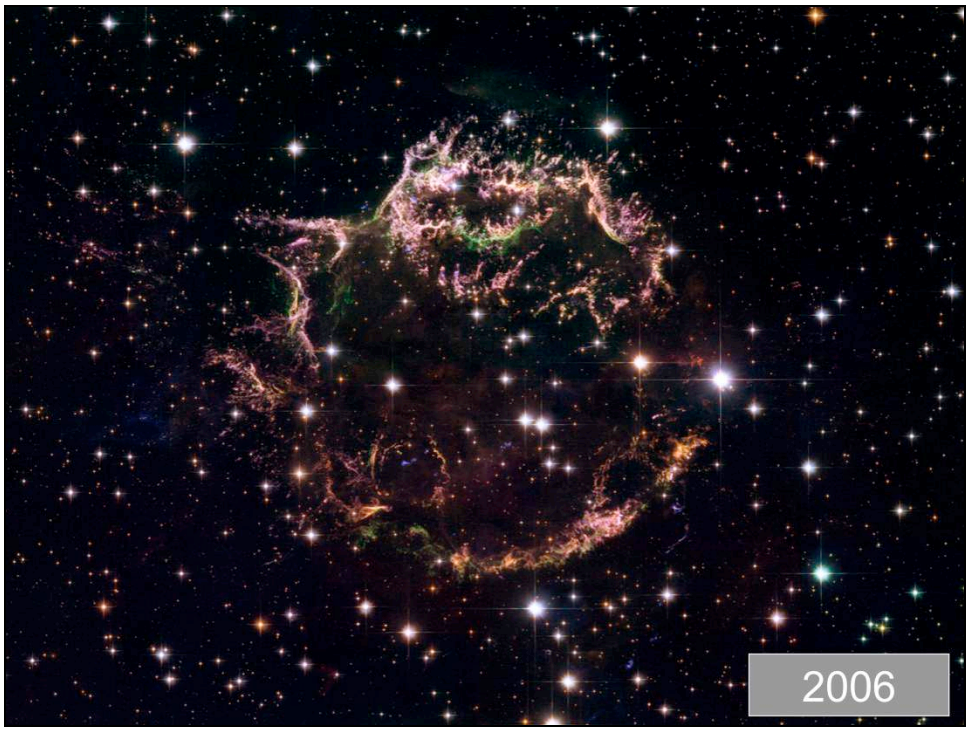
This image shows workers building the STIS instrument before its launch in 1997.



This 91 million pixel mosaic of the Whirlpool Galaxy was released to celebrate Hubble's 15th Anniversary.

Beyond the sheer beauty of the image, the details along the spiral arms follow the progression of star formation from dark dust clouds through pink star-forming regions to blue newborn star clusters.

http://hubblesite.org/newscenter/archive/releases/2005/12/



In contrast to the decades old SN 1987A, the supernova remnant Cassiopeia A is about 340 years old, and shows the dispersing of the cloud across interstellar space. However, the interior of this visible light bubble is not empty, it is filled with extremely hot gas that shows up in x-ray observations from the Chandra X-ray Observatory.

NASA's Great Observatories: Hubble, Chandra, and the Spitzer Space Telescope (infrared light); often observed the same objects to gather complementary and contrasting views and further our astronomical understanding.

http://hubblesite.org/newscenter/archive/releases/2006/30/

Michael Griffin (leftmost in this image) succeeded Sean O'Keefe as NASA Administrator and oversaw the Space Shuttle's return to flight in 2005.

After considerable internal study, NASA determined that a mission to Hubble could be possible, but only if a second Space Shuttle were ready on the launchpad for a possible rescue mission.

In October 2006, with that requirement in place, the final servicing mission to Hubble was re-instated. Servicing Mission 4 was slated for October 2008.

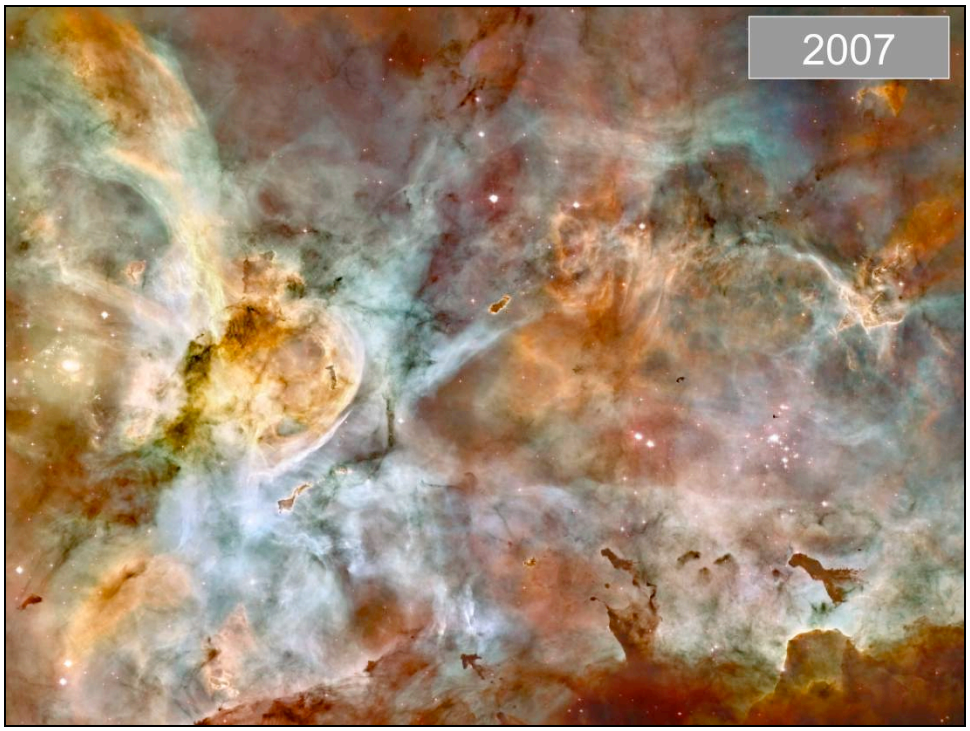
This image is from the Space Shuttle return to flight press event on June 30, 2005.

In early 2007, another instrument failure had a major impact on Hubble's science productivity.

Side 1 of the ACS electronics failed in July 2006, and Side 2 failed in January 2007. Hubble lost its main camera, and returned to using WFPC2, installed in 1993 during Servicing Mission 1.

New instruments would be installed during Servicing Mission 4, but that was over a year and a half away.

This image shows the ACS instrument in the clean room before its launch in 2002.

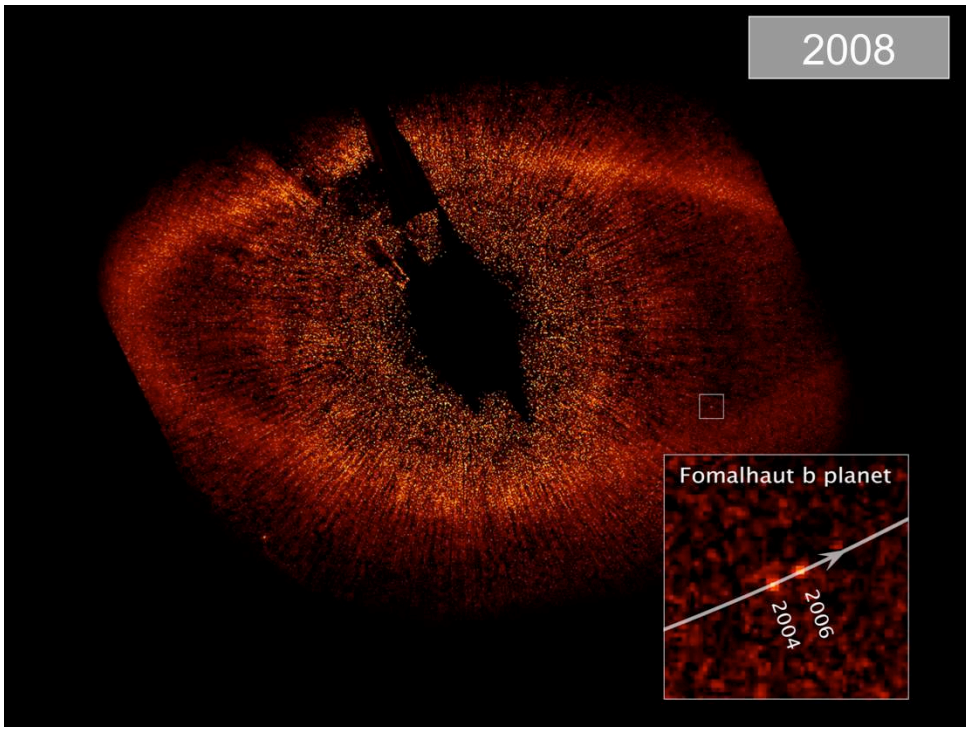


This vibrant image of the Carina Nebula is the largest mosaic released by Hubble until 2015 (the PHAT mosaic of the Andromeda Galaxy is currently the only larger one).

Because Hubble only observed the full region in one filter, the image combines those Hubble observations, which capture the high-resolution details, with ground-based images to provide the color information.

The Carina Nebula is so rich in detail that no less than five Hubble press releases have featured parts of this region.

http://hubblesite.org/newscenter/archive/releases/2007/16/



Planets around other stars have been discovered since the mid-1990s. However, all of those hundreds of initial planets were detected by indirect means. No one had ever presented a direct image of a extrasolar planet until November 2008.

This image shows a ring of dust around the star Fomalhaut. The light from the central star has been blocked by a coronagraph. Because the ring was off-center, astronomers used Hubble to search for a planet that could be pulling on the ring.

Within the small square is a red dot that was determined to be the planet. The two observations in the inset image show that its orbit is consistent with the sought after planet. Hubble captured the first-ever visible light image of a planet around another star.

Note: Coincident with the Hubble announcement was the release of infrared direct observations of three planets around the star HR 8799. A week later, an image of a planet around Beta Pictoris was released, though it was not yet fully confirmed. Astronomy knowledge changed from zero to five images of extrasolar planets in a fortnight.

In late September 2008, two shuttles were on the launchpads, ready for Servicing Mission 4.

Atlantis, in the foreground, would carry the astronauts to service Hubble, while the Shuttle Endeavor, in the background, was on standby in case a rescue mission was needed.

The long-awaited, canceled and reinstated, final servicing mission was only weeks away.

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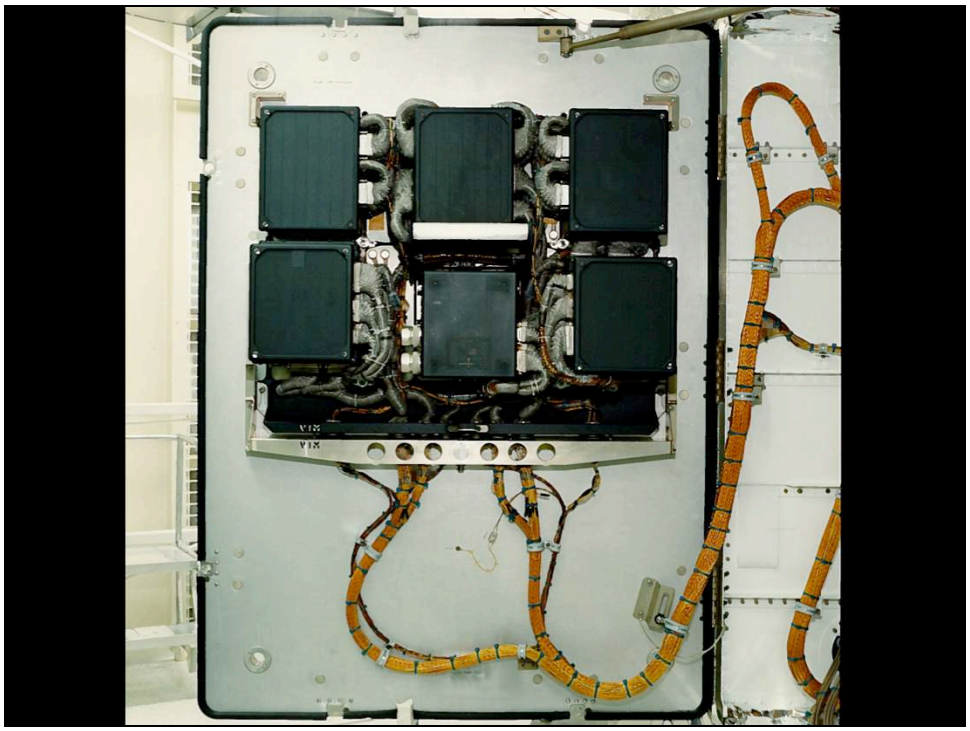

Then, on September 27, 2008, the Science Instrument Control and Data Handling Unit (SIC&DH) onboard Hubble had an electronics failure. This hardware had not had a problem in 18 years of operation and was soon recovered by switching to backup electronics.

However, the SIC&DH is a critical piece of equipment, without which almost no science can be done on the observatory. NASA did not want to leave Hubble with such a single point of failure after its final servicing.

SM4 was delayed, yet again, while a ground spare unit was readied for space operation.

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Servicing Mission 4 (STS-125, Space Shuttle Atlantis) finally launched in May 2009.

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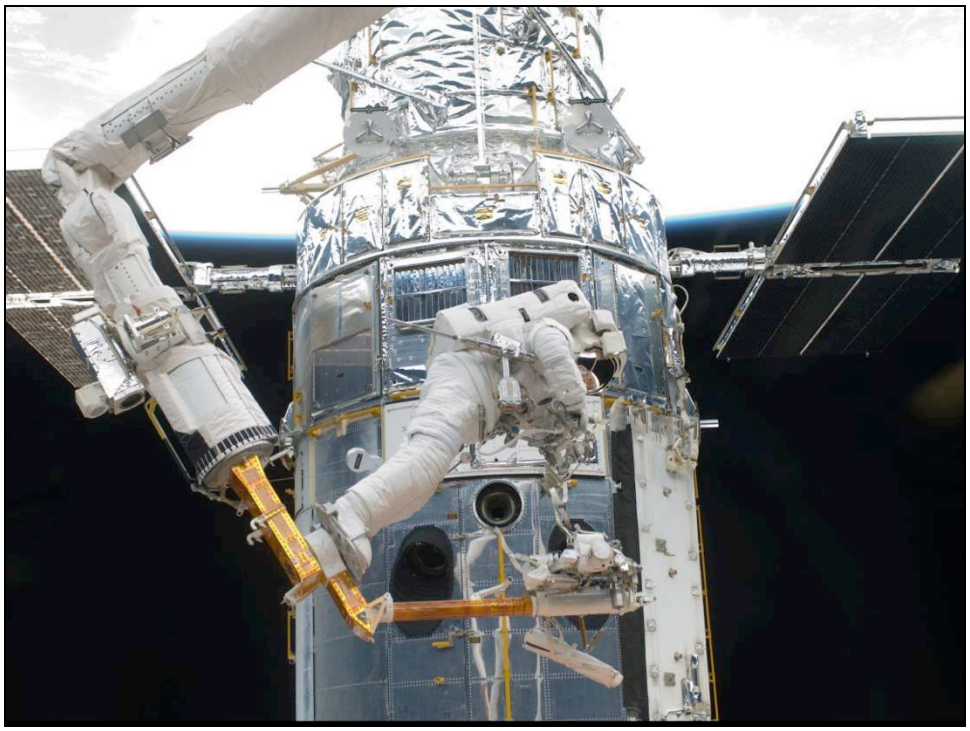

The list of work to be done was long and ambitious, including the primary objectives of installing the new Wide-Field Camera 3 (WFC3) and the Cosmic Origins Spectrograph (COS). WFC3 would provide significantly enhanced ultraviolet and infrared capabilities for Hubble's main cameras.

Astronauts also were attempting to repair both ACS and STIS, although neither was designed for servicing in space.

Despite a few sticky problems during five long spacewalks, the astronauts accomplished everything. The crew left Hubble in the best shape it has ever been.

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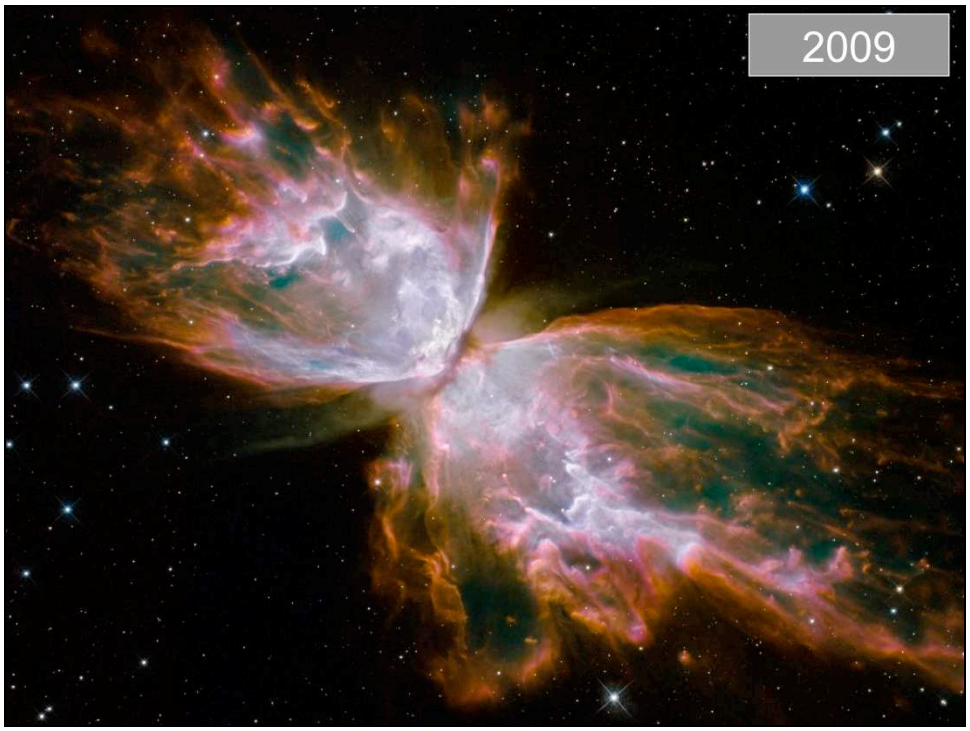
This image of Hubble after SM4 is bittersweet.

While Hubble had been “repaired, refreshed, and renewed”, it was also the last time astronauts would visit Hubble.

This image is part of the final goodbye shots.



Once again, the press release announcing Hubble's return to science operations featured some staggeringly beautiful images.

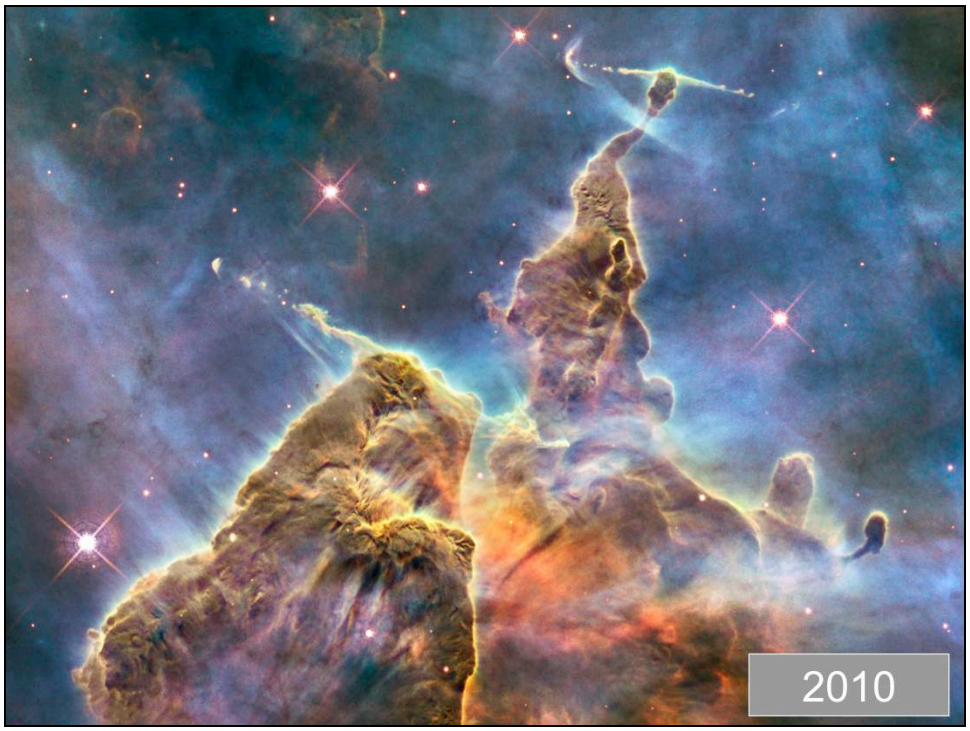
This planetary nebula is the material blown off of a dying star. A disk around the center restricts the outflows into two oppositely directed lobes, creating a distinct resemblance to a butterfly.

Although named the Bug Nebula, many began calling it the Butterfly Nebula after this image was released.

http://hubblesite.org/newscenter/archive/releases/2009/25/

In March of 2010, IMAX released its documentary “Hubble 3D”. With powerful footage shot in space, the film told of the struggles and triumphs of Hubble Servicing Mission 4.

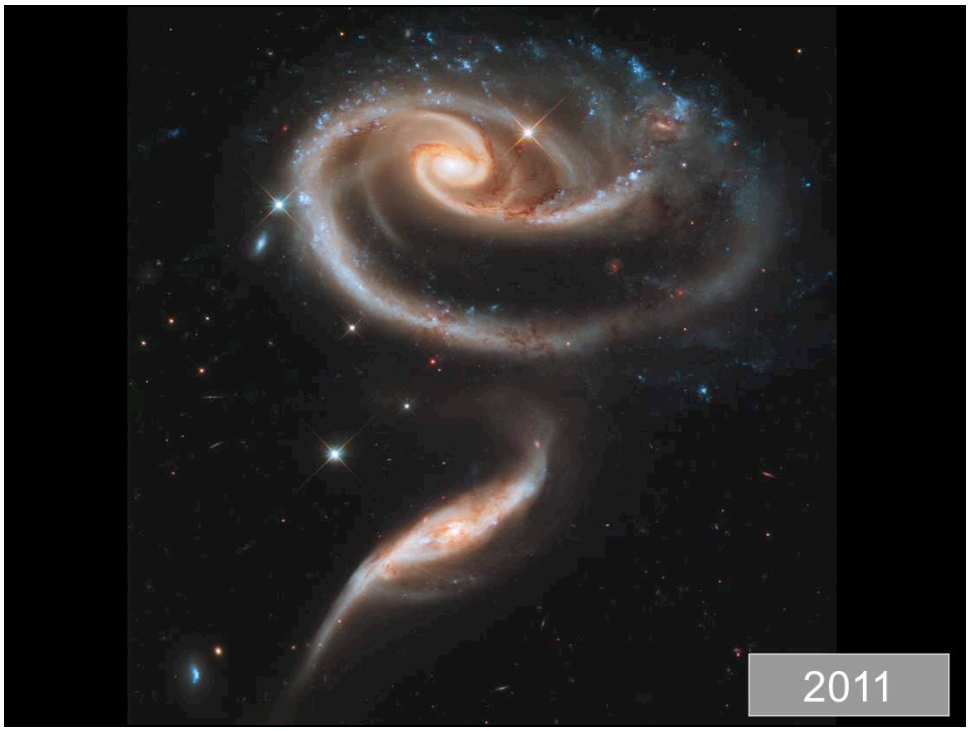
It has become one of the most successful IMAX documentaries ever, with a worldwide box office of over $65 million (as of January 2015).



Hubble's 20th Anniversary was celebrated with these gorgeous gaseous pillars in the Carina Nebula, nicknamed "Mystic Mountain".

High energy ultraviolet radiation and strong stellar winds from hot young stars heats and erodes the dense dark gas of the pillars. The jets emanating from the tops of two pillars are emitted by newborn stars formed within the dense clouds.

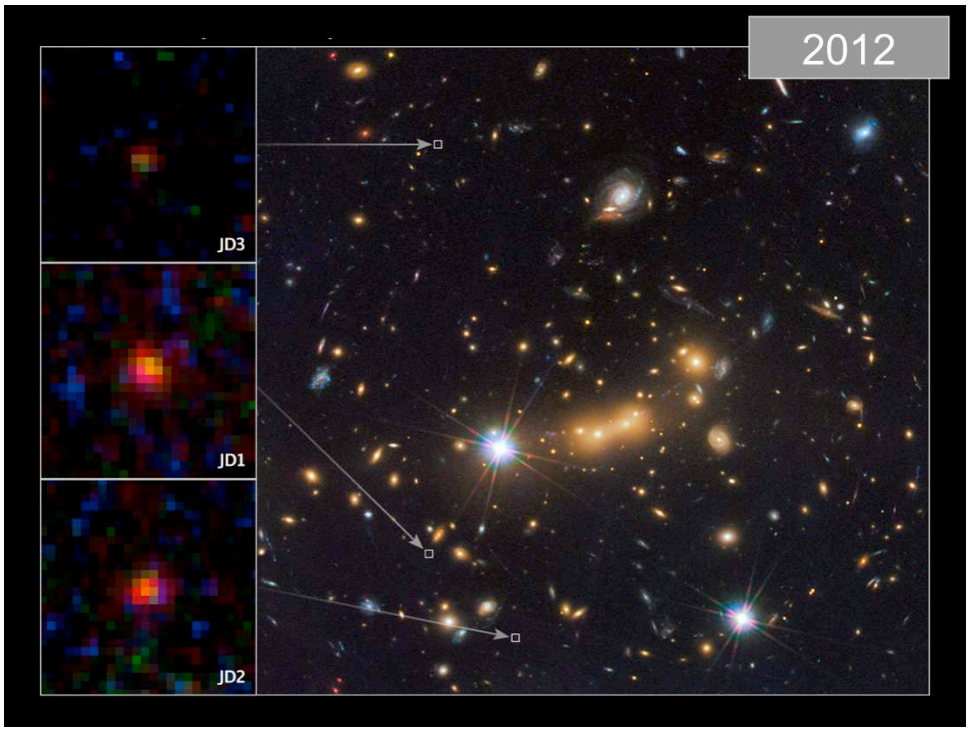
http://hubblesite.org/newscenter/archive/releases/2010/13/



Galaxy interactions are not always the grand collisions seen in the Antennae and the Mice. The two interacting galaxies, called Arp 273, have produced less pronounced distortions in each others' shape.

Some called this picture a "rose" of galaxies, with the upper galaxy as the bloom, and the lower galaxy as the stem.

http://hubblesite.org/newscenter/archive/releases/2011/11/

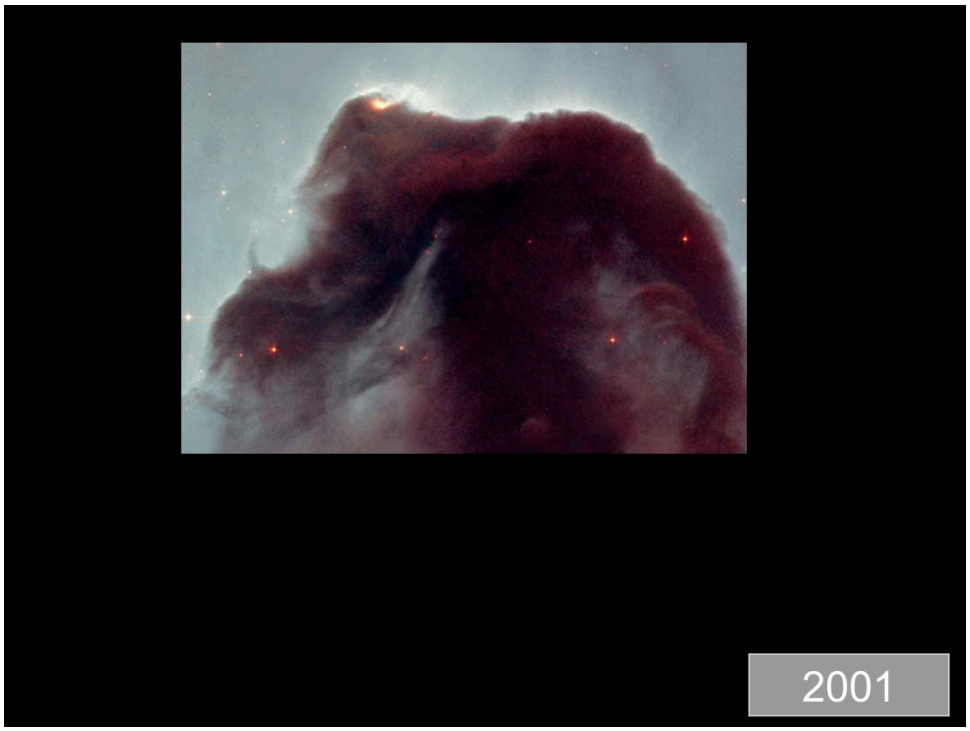


Gravitational lensing can not only distort the shapes of more distant galaxies, it also can magnify their brightness. In this image, the galaxy cluster acts as a complex lens and produces three images (JD1, JD2, and JD3) of the same background galaxy.

The most interesting point is that this distant galaxy is too faint for Hubble to observe directly. It is the combiniation of Hubble's optics with the galaxy cluster gravitational lens that enables it to be seen.

By taking advantage of these natural lenses in space, astronomers can see a bit farther and deeper into the universe.

http://hubblesite.org/newscenter/archive/releases/2012/36/



In 2001, after asking the public which object should be observed, the Hubble Heritage Project took this image of the Horsehead Nebula.

While the nebula makes for a striking silhouette, the dark cloud is short on detail in a visible light image.

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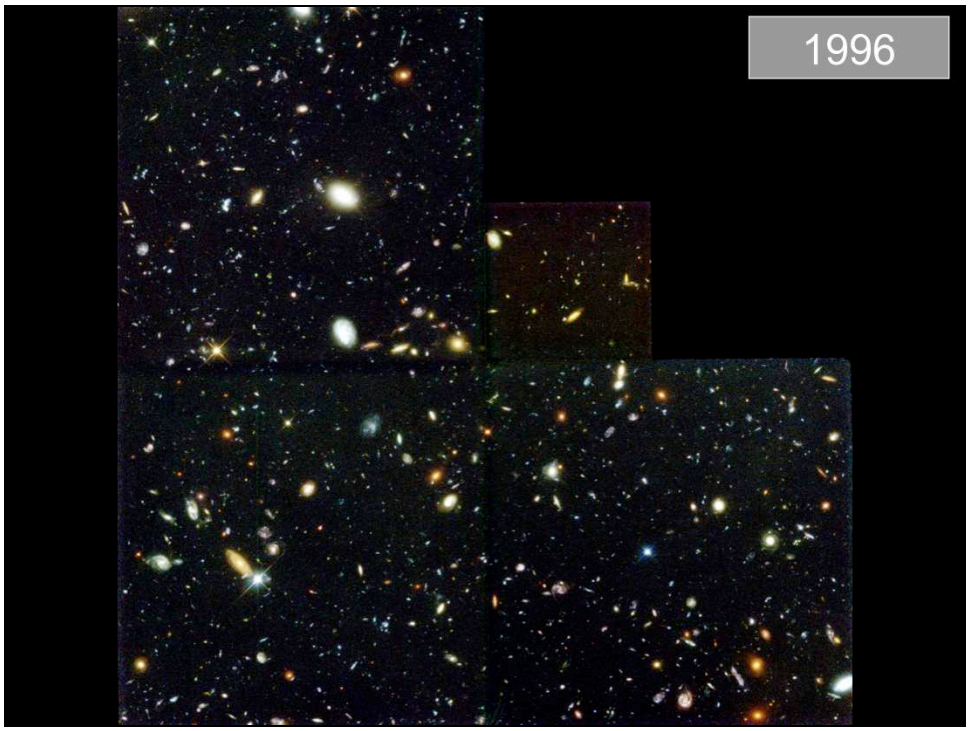
http://hubblesite.org/newscenter/archive/releases/2001/12/

Using the enhanced infrared sensitivity of WFC3, Hubble was able to get much more detail in this infrared portrait.

The relatively featureless dark clouds are transformed into a glowing gaseous landscape.

http://hubblesite.org/newscenter/archive/releases/2013/12/



A noticeable omission so far in this review of Hubble observations are the deep fields. These are left to almost last, both for their significance and their long history.

The original Hubble Deep Field (HDF) was remarkable first because it succeeded where many thought it could only fail. Some predictions for distant galaxies indicated that they would be too small for even Hubble to resolve, and the immense amount of observing time required for the search would be wasted.

Instead, it was a tremendous success. The HDF found about 3000 galaxies in a single WFPC2 field, and gave astronomers the ability to study the distant universe as never before.

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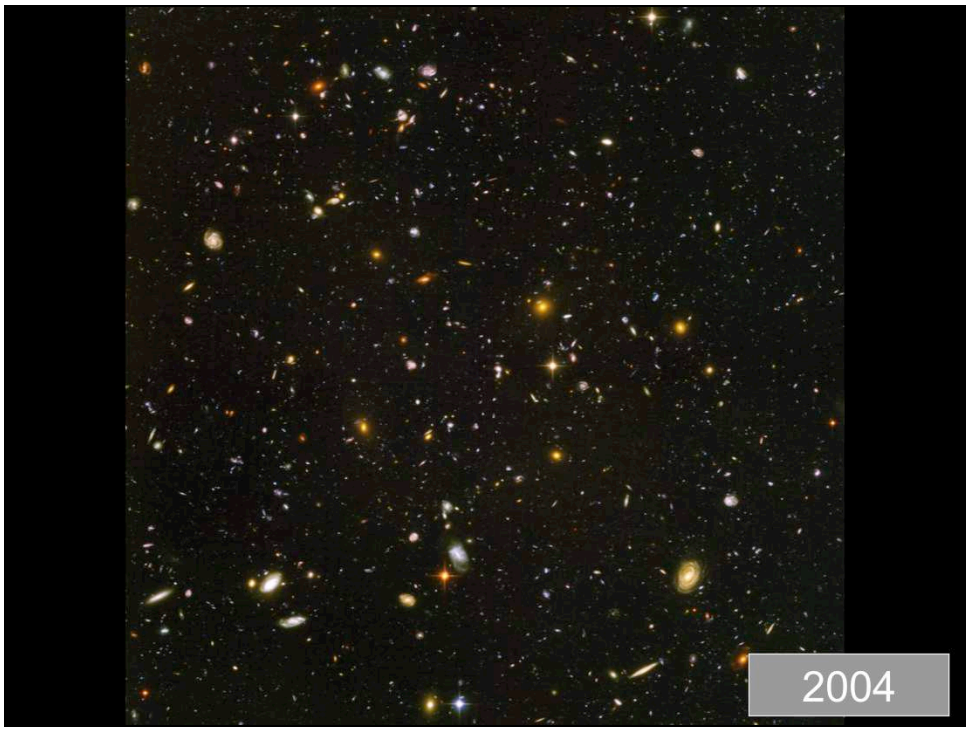
http://hubblesite.org/newscenter/archive/releases/1996/01/



Following the ACS upgrade of SM3B, another deep field was commissioned to take advantage of the instruments' new capabilities. Combining over 11 days of cumulative exposure time, the Hubble Ultra Deep Field (HUDF) uncovered about 10,000 galaxies.

These galaxies cover vast stretches of both space and time. Light from these distant galaxies has traveled for billions of years across space, meaning that we see these galaxies as they were billions of years ago.

The HUDF lets astronomers study the history and development of galaxies over twelve billion light-years of space and twelve billion years of time.

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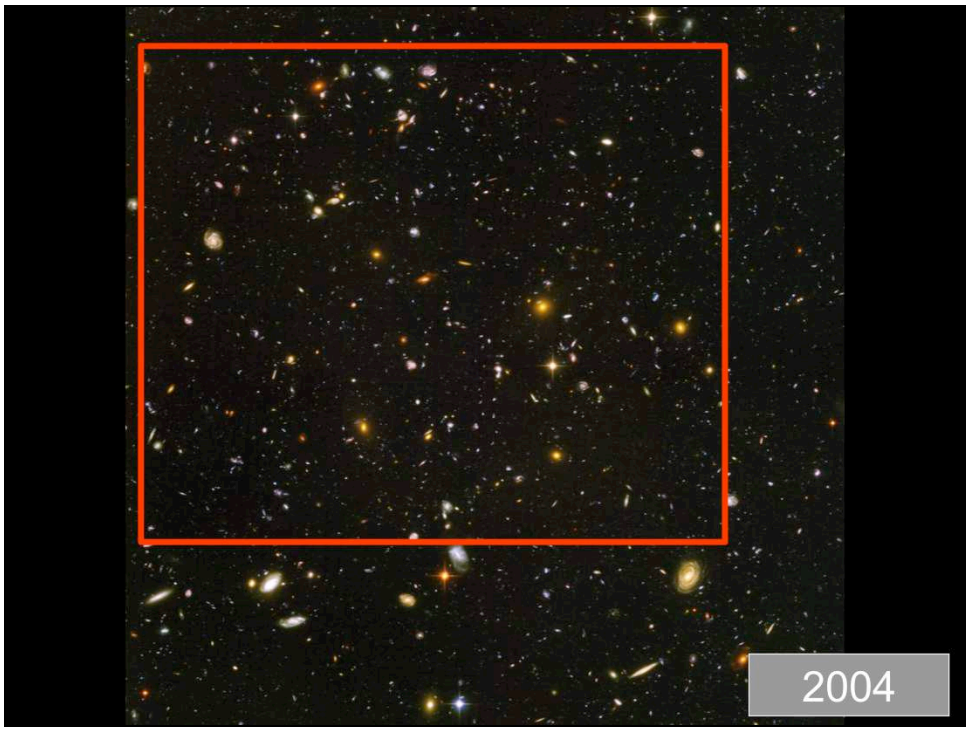
http://hubblesite.org/newscenter/archive/releases/2004/07/



The WFC3 instrument, installed during SM4, improved Hubble's infrared capabilities, though its infrared detector had smaller field of view.

This region within the HUDF was selected for deeper infrared study.

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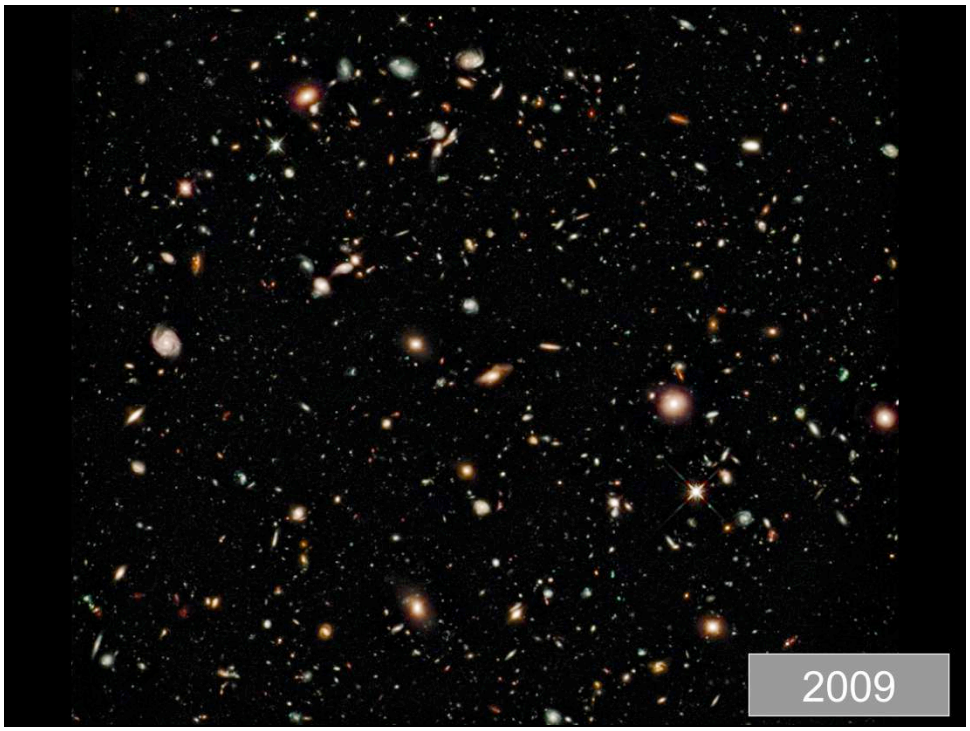

The HUDF-IR from 2009 increased the important infrared component of the previous observations.

The expansion of the universe stretches light waves in a phenomenon known as cosmological redshift. The more distant the galaxy, the longer its light has travelled across expanding space, the greater the stretching due to cosmological redshift.

Light from the most distant galaxies is stretched beyond visible wavelengths, such that they are only observable in infrared wavelengths. The HUDF-IR enabled detection of galaxies back to the first billion years after the big bang.

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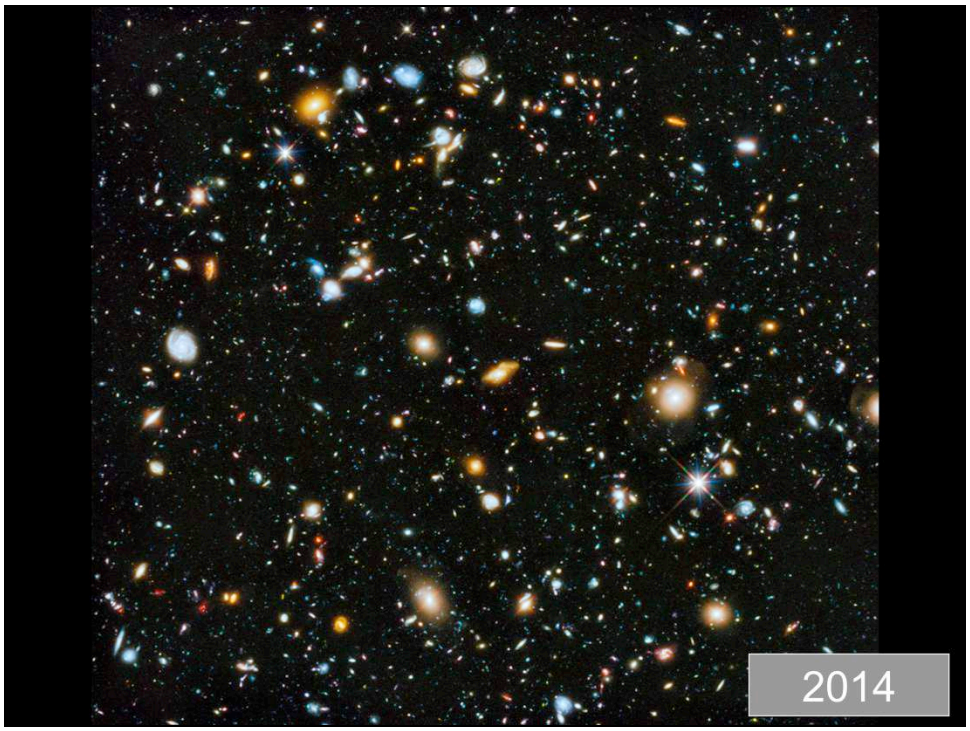
http://hubblesite.org/newscenter/archive/releases/2009/31/

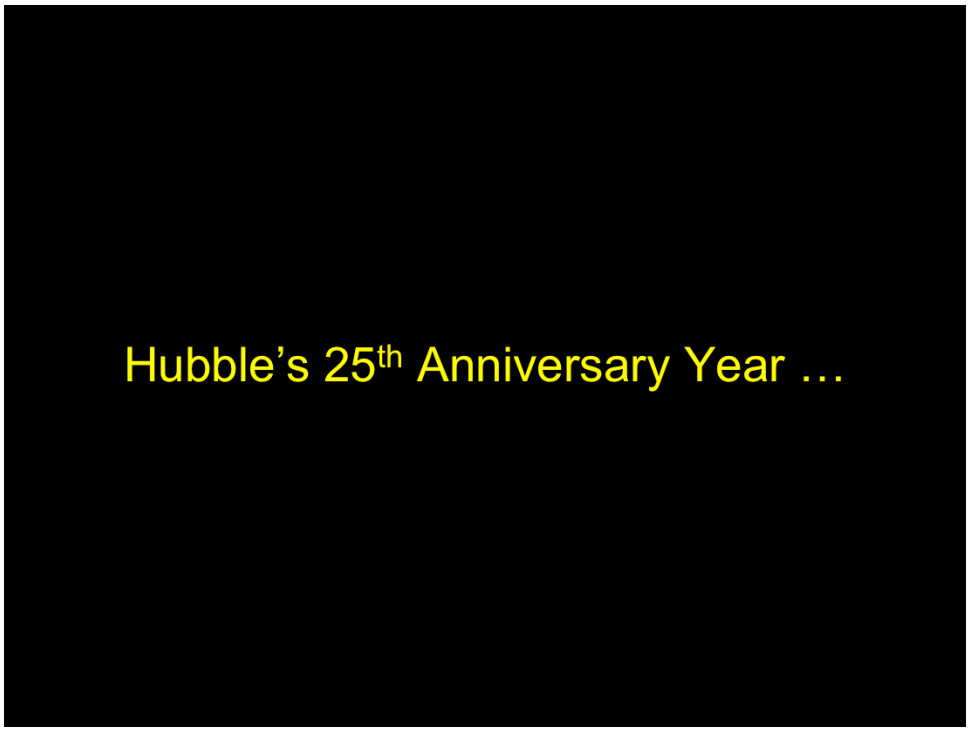


The one piece of the spectrum still missing from the HUDF images was ultraviolet light.

The WFC3 instrument had also improved Hubble capability in the ultraviolet, and these observation were added to create the Multiwavelength HUDF in 2014.

This deep field image captured the complete spectral range; ultraviolet, visible, and infrared; that Hubble could provide.

http://hubblesite.org/newscenter/archive/releases/2014/27/



After all that amazing astronomical awesomeness, how do we top it for the 25th Anniversary?

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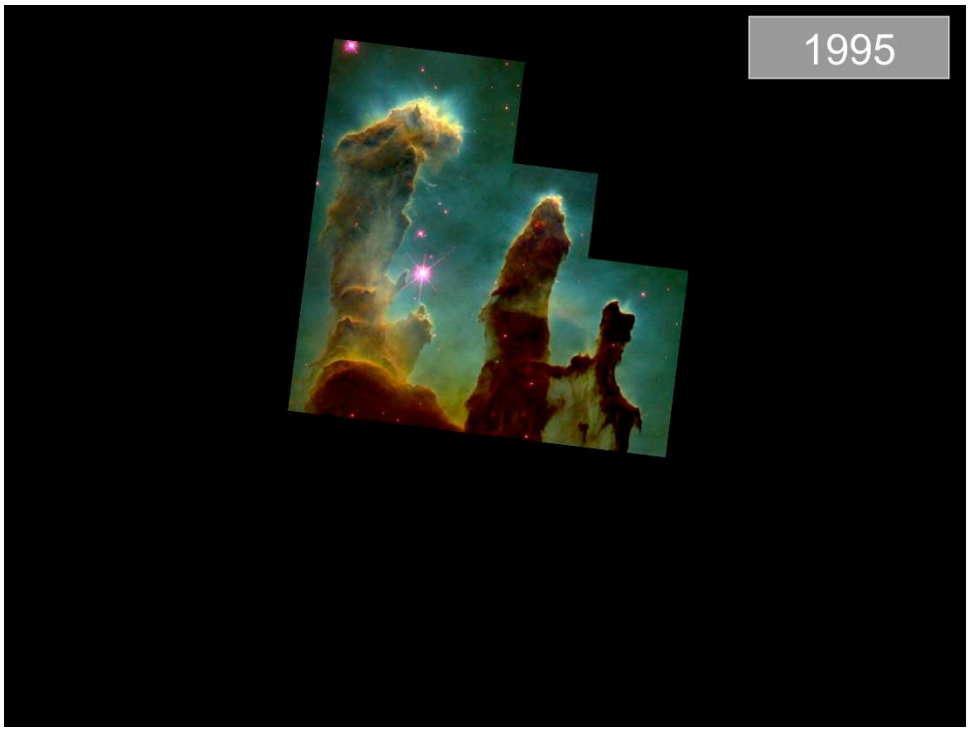

We begin the anniversary year by revisiting a legendary image: the “Pillars of Creation” in the Eagle Nebula. This image was the first Hubble image to capture the public’s fascination, and still remains one of the most popular images.

Like the pillars in Carina, these dark clouds are being eroded by winds and radiation from hot, young stars. The stars forming within the pillars gives them their “creation” nickname.

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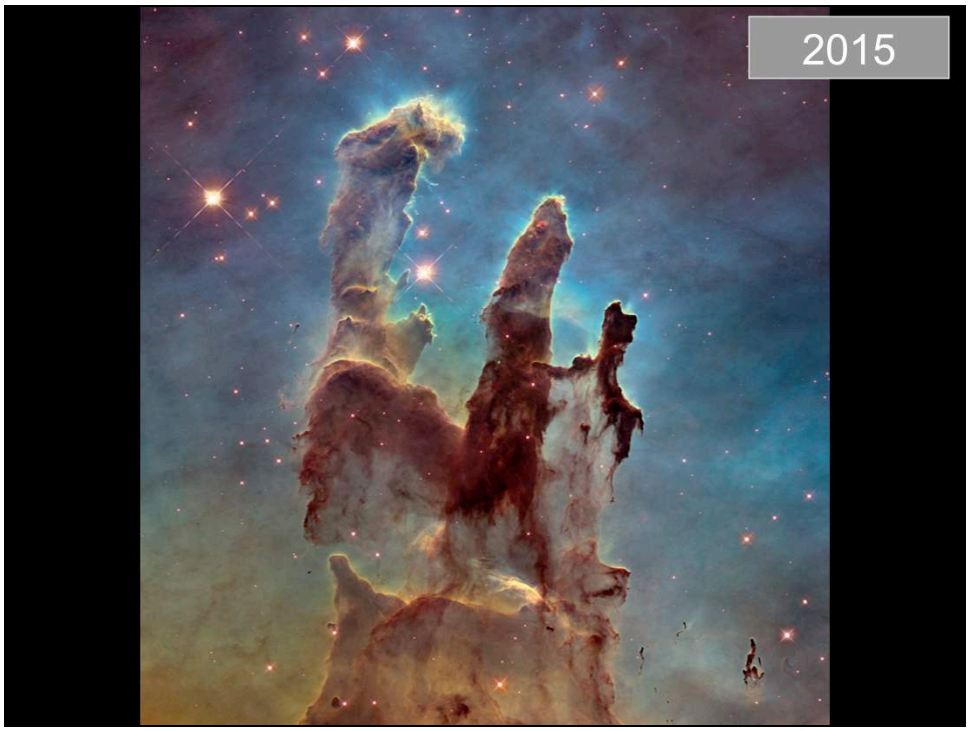
http://hubblesite.org/newscenter/archive/releases/1995/44/



Using Hubble's newer cameras provides a stunning new image of an old favorite. This image has twice the resolution, several times the area, and more than twenty times the pixels of the 1995 version.

The taller image includes the gas at the bottom of the pillars being blown down and trailing away. Numerous small features indicate the pervasiveness of pillars of every size in this region.

And yet, Hubble can go one step more …

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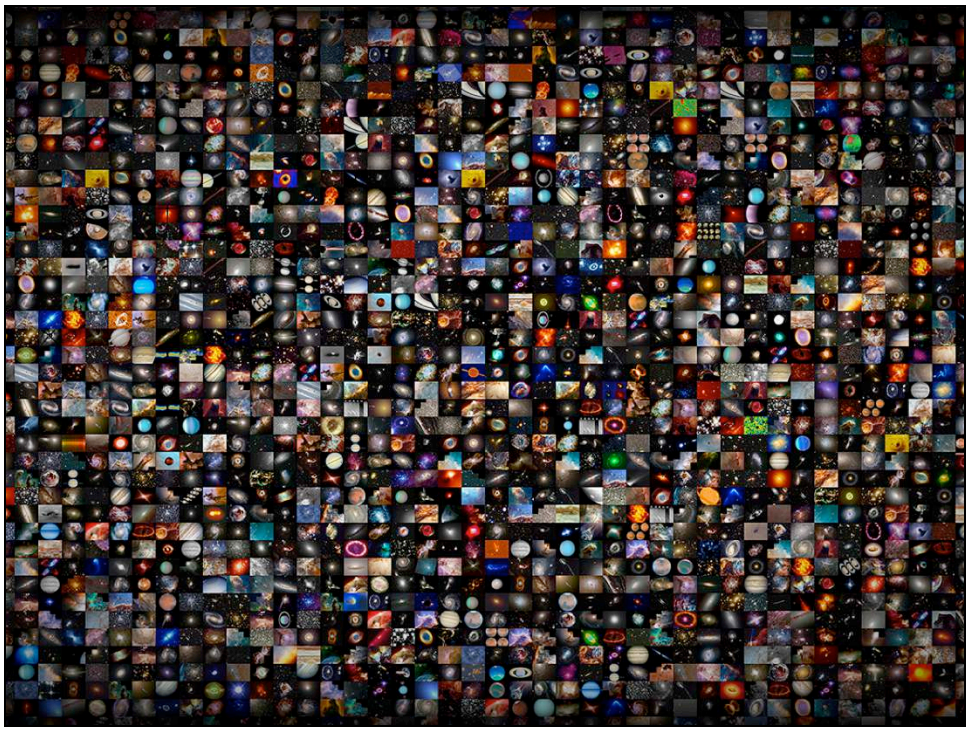
http://hubblesite.org/newscenter/archive/releases/2015/01/

Using the infrared capabilities of WFC3, one can see the pillars in a whole new light.

Much of the gas of the nebula is transparent to the longer wavelengths of infrared light, revealing a tremendous number of stars. The seemingly solid visible light pillars are shown in the infrared to be a combination of dense clouds and the shadows they cast behind them.

Such high resolution visible light and infrared light comparisons point toward a bright future when Hubble and James Webb Space Telescope observations can be similarly compared and contrasted.

http://hubblesite.org/newscenter/archive/releases/2015/01/



Much of the discussion here, and most of the public's attention, is focused on Hubble's images. Here is a montage created for the 20th Anniversary that captures the breadth and depth of Hubble observations.

However, it is the scientific output that is the true measure of a telescope.

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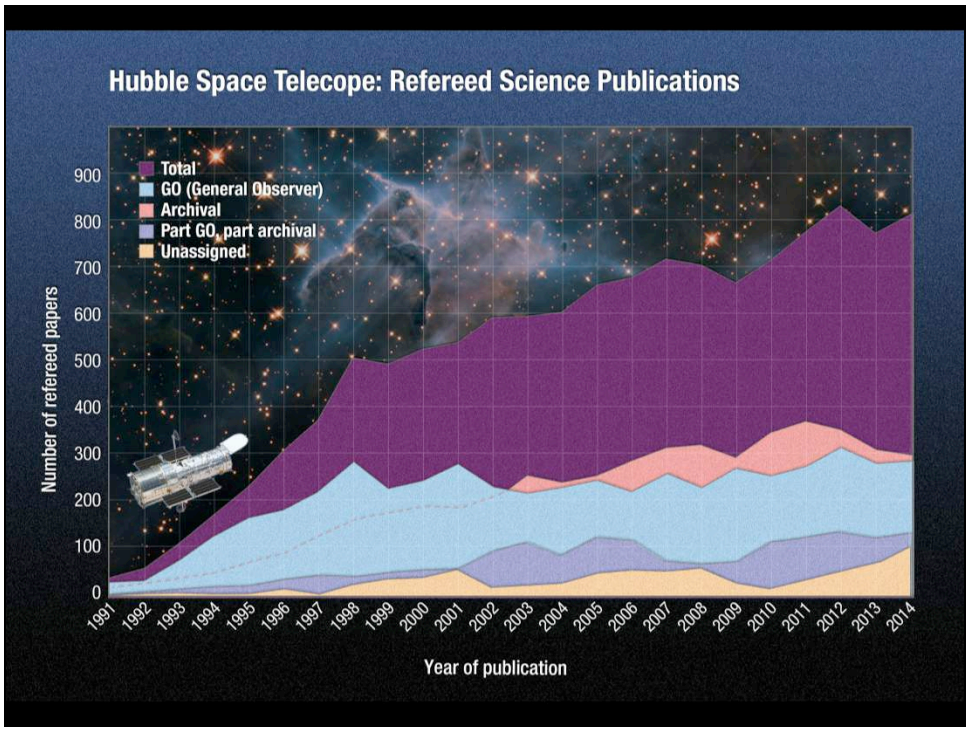

By the measure of refereed science papers, Hubble has been incredibly productive.

This plot shows that papers based on both new and old (i.e., archival) Hubble data have grown to about 800 per year. The cumulative total is over 12,000 as of the end of 2014.

Hubble is easily the most productive space mission of all time, and might be the most productive telescope in history.

To finish, let's consider this poetic view of Hubble hanging over the limb of Earth. You can see the fuzzy edge of Earth's atmosphere, and Hubble position above it that gives it its main advantage. Hubble, gazing off into the universe, collecting new images and new discoveries, presents a hopeful look into the future.

And, although Hubble is 25 years old, it still has a bright future ahead of it. It is not just that the observatory is operating well, but also that the experience gained in decades of operations have greatly improved its productivity. In many ways, Hubble is still at the peak of its capabilities. While we have long targeted a goal of operations through 2020 and some overlap with the James Webb Space Telescope, a mission beyond that time is not out of the question.

For now, join with NASA, ESA, and the entire Hubble team in recognizing the remarkable achievements and astounding imagery from a telescope that has transcended science and become part of the public culture. It is the 25th Anniversary of not just the astronomers' telescope, but the people's telescope, and time for a celestial silver celebration!