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News

Hubble Space Telescope clocks up 20 years

***Nature* looks at a troubled history, some remarkable discoveries and the future of the instrument.**

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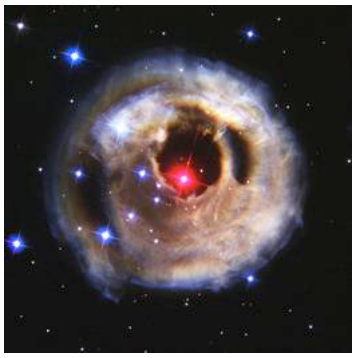

See *Nature*'s Hubble anniversary **slideshow** for more stunning images.

NASA/ESA/H.E. Bond

It was an instrument that much of the astronomical community didn't want, but times change: to get time now on the Hubble Space Telescope, which is celebrating its 20th anniversary this week, an astronomer usually faces competition from at least 11 other eager scientists.

Hubble, named after American astronomer Edwin Hubble, has been orbiting Earth for 20 years, sending back images in the visible, near-infrared and ultraviolet parts of the spectrum. In that time it has undergone major surgery, proved the existence of dark matter, given insight into the life and death of supernovae, and captured the public's imagination with its pictures. And throughout all this, the instrument's very survival has been threatened more than once.

Hubble's recent history began in 1962, when the National Academies of Science recommended a space telescope be built, although astrophysicist Lyman Spitzer had put forward the idea in the 1940s. In 1970 NASA began to investigate the feasibility of such an instrument. This led Bob O'Dell, now at Vanderbilt University in Nashville, Tennessee, to take a risk: in 1971 he left his job at the University of Chicago to become Hubble's first project scientist. "I gave up a tenured professorship. I resigned from that to gamble on a project that wasn't even funded," says O'Dell. Over the next 12 years he set about selling the idea to NASA funders, and to his peers, many of whom would have rather seen NASA pay for 20 ground-based telescopes and didn't think that the advantage of being above the atmosphere was worth the trouble, he says.

And O'Dell succeeded. The independent Space Telescope Science Institute was established in Baltimore in 1983 to run the telescope's scientific operations and get data to scientists. The first launch, slated for 1986, was delayed by the *Challenger* shuttle disaster, and technical problems. Then on 24 April 1990, the space shuttle *Discovery* launched the Hubble Space Telescope into its orbit 575 kilometres above Earth.

First light

Immediately there was a problem. The mirror was the wrong shape at the edges, which made Hubble's first images blurry. O'Dell insists that the pictures were still better than ground-based observations, but because of the 'halo' of blurriness, only the middle 20% of an image was tightly focused. Algorithms were produced to compensate for this but another problem was the unexpected shaking of the telescope due to solar winds as it went from sunlight to darkness on each orbit. Hubble detractors and the press were quick to claim that the instrument was a "techno turkey," says O'Dell.

Servicing missions have kept Hubble at the cutting edge of science. *NASA*

Help was at hand. The telescope was designed to be constantly serviced, with no limit fixed to its ultimate life span — and after the first servicing mission in December 1993 the optics were upgraded and pictures came into sharper focus. Since then, Hubble has had four more services, performed by astronauts delivered by the shuttle. "The Hubble of today is not the Hubble that launched," says astronomer Sandra Faber at the University of California, Santa Cruz, and the Lick Observatory. She calculates that today the instrument is 60 times more powerful than in 1990.

Between 2003 and 2006 Hubble's future looked uncertain (see **'NASA budget kills Hubble telescope'**). The final servicing mission was cancelled in 2004 by then-administrator of NASA Sean O'Keefe. His successor Mike Griffin reinstated the mission in 2006, and it finally took place in May 2009.

Hubble goes supernova

But running alongside Hubble's tribulations were the scientific successes. "Hubble is the most important telescope in history after Galileo's first telescope," says Faber. The ability to look farther back in our Universe's history than before, and see it evolving, is of fundamental importance and Hubble allowed this to happen, says Faber. "Hubble has established for the first time that the distant Universe looks different from the nearby Universe," she says (see **'Camera gets deepest view of Universe'**).

"Hubble is the most important telescope in history after Galileo's first telescope."

Robert Kirschner at Harvard University in Boston, Massachusetts, studies supernovae. Hubble provided Kirschner, and other groups, with evidence that the Universe's expansion was accelerating — which turned on its head the idea prevalent at the time that the expansion of the Universe was slowing (see **'Eleven years of constant searching is over'**). The proof came from observations of supernovae, the final explosions of very large dying stars. The light from these supernovae, detected by Hubble, came from much farther away than predicted. This proof of the accelerating expansion of the Universe is, according to Faber "the most profound discovery in physics since quantum physics and general relativity".

Hubble provided information for astronomers to pin down the properties of dark energy, again by looking at supernova says Kirschner (see **'Hubble sees dark energy's youth'**). Later, in 2006, Hubble also proved the existence of dark matter (see image 12 of the **slideshow**). And Faber has used Hubble to show that the size of a black hole is related to the size of its accompanying galaxy.

Dying star

O'Dell used his time on the Hubble project to take a closer look at our starry neighbour the Orion nebula, and the planet-forming regions around young stars within it. "We were able for the first time to image the protoplanetary disks around these young stars," says O'Dell. "You could never get that kind of angular spectral resolution with ground-based telescopes," he says. O'Dell has since been looking at the jets erupting from stars and how they interact with the ambient material in nebulae.

Hubble has taken stunning pictures of various nebulae, and in 2001 an internet poll allowed the public to pick which starry spectacle Hubble should take a close-up image of. The winner was the Horsehead nebula. Hubble has also managed to take the deepest image ever of our Universe, the Hubble Ultra Deep Field (see image 15 of the **slideshow**). The telescope has teamed up with other space-based instruments to take a wider look at the radiation in space: the Chandra X-ray observatory and the Spitzer space telescope (which covers the infrared) between them complement Hubble's imaging capability to stunning effect.

Now that Hubble is 20, its future has been assured until the end of April 2013, with a recent extension of the operations contract by NASA. After that its future is uncertain. No more servicing missions are planned and gradually the batteries, solar panels and telescope-pointing machinery will begin to fail. Hubble's work will be continued in part by the James Webb Space Telescope, set to launch in 2014.

Until 2013 Kirschner is hoping that Hubble and its instruments (the Advanced Camera for Surveys, Cosmic Origins Spectrograph, Fine Guidance Sensors, Near Infrared Camera and Multi Object Spectrometer, Space Telescope Imaging Spectrograph and Wide Field Camera) will remain in good health. O'Dell is confident that the instrument has five years work left in it. With an oversubscription of 11-1 we can be sure that every second of the telescope's remaining lifetime will be used to its maximum capability, he says.

*See Nature's Hubble Space Telescope **special**, which includes more than 15 years of freely accessible news stories as well as a **slideshow** and selected research papers.*

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