

- [hubblesite.org/](http://hubblesite.org/)  
This site allows students to track the location of NASA's orbiting Hubble Space Telescope, and includes a gallery of amazing images, as well as plans to make a scale model of the instrument.
- [liftoff.msfc.nasa.gov/](http://liftoff.msfc.nasa.gov/)  
This site was developed for teenagers interested in space missions. It contains news updates and background information on NASA's missions.
- [www.jwst.nasa.gov/](http://www.jwst.nasa.gov/)  
This NASA site explains how scientists worked together to develop the James Webb Space Telescope in order to observe the first stars and galaxies in the universe.
- [www.exploratorium.edu/spectra\\_from\\_space/](http://www.exploratorium.edu/spectra_from_space/)  
This Exploratorium site describes space probes that are now in orbit, including the Hubble Telescope, listing their purposes and some of their interesting discoveries.

### Suggested Print Resources

- Kirshner, Robert. *The Extravagant Universe: Exploding Stars, Dark Energy, and the Accelerating Cosmos*. Princeton University Press, Princeton, NJ; 2002.
- Trefil, James & David H. Levy. *Other Worlds: Images of the Cosmos from Earth and Space*. National Geographic Society, Washington, D.C.; 1999.
- Voit, Mark. *Hubble Space Telescope: New Views of the Universe*. Harry Abrams Publishing, New York, NY; 2000.

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#### TEACHER'S GUIDE

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#### COMPLETE LIST OF TITLES

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- 21ST CENTURY COSMOS
- THE CASE FOR MARS
- THE ENIGMA OF VENUS
- EXTREME ASTRONOMY
- HUBBLE'S HERITAGE
- THE SEARCH FOR NEW PLANETS
- STELLAR EVOLUTION
- THE STORY OF COMETS
- TRAVELING TO OUTER PLANETS

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## Hubble's Heritage

### Grades 9–12

This series tells the stories behind the science of astronomy in an informative and entertaining way. Fast-paced and visually rich, viewers journey to exotic destinations within our solar system from moons and planets to comets and asteroids. Featuring advances in scientific investigation, this series investigates cosmic mysteries including the birth and death of stars, the structure of the universe, and the search for extraterrestrial life.

This guide provides a brief synopsis of the program, background on the science concepts presented in the show, discussion topics, activities, vocabulary and additional resources.



## Program Summary

*Hubble's Heritage* looks at the remarkable gallery of images collected by the Hubble Space Telescope (HST) and introduces some of the scientists who study them. We look at the HST through dramatic video footage of its launch and from the various servicing and repair missions that have sustained it over the years.

From its position 380 miles above Earth's surface, the Hubble Space Telescope has contributed enormously to the science of astronomy. It has expanded our understanding of star birth, star death, galaxy evolution, and has moved black holes from scientific theory to scientific fact. With more than 100,000 images to its credit since its launch in 1990, the telescope has become perhaps the best-known observatory ever built, and is still helping scientists answer one of the oldest questions known to humankind: how big and how old is our universe?

The HST is a space-based telescope with an extremely checkered history. Launched in 1990 from the space shuttle after a four-year delay, astronomers all over the world were quickly devastated to learn that a defect in the instrument's lens made it incapable of "seeing." It was a huge embarrassment for the American space program as scientists realized that their observing projects, years in the planning, might never be carried out. The space shuttle Endeavor was dispatched in 1993 to repair the crippled billion-dollar telescope. The crew trained for months, and over the course of several lengthy space walks, the astronauts replaced the faulty components with a set of corrective optics. The HST could see!

The HST has certainly provided some of the clearest views of star-forming regions, of early planet formation and of distant galaxies. The Hubble Heritage Project is an online collection of the very best of thousands of images that the HST has returned over its years in space, chosen by the people who manage the instrument. Once Hubble gathers pictures and data on celestial objects, its computers turn the information into long strings of numbers that are beamed to Earth as radio signals. Scientists and computer programmers then turn the signals into images and data for analysis. Many of these amazing glimpses are posted in glorious (if not always natural) color on the Internet, and some of them represent major scientific breakthroughs.

The development of telescope technology has come a long way since the early 1980s when HST was designed. Those dramatic scenes of astronauts working on the Hubble are a thing of the past. The James Webb Space Telescope (formerly known as the Next Generation Space Telescope, or NGST) is destined to be the next generation's eyes on the universe. To fully exploit its advantage of being beyond the atmosphere, the HST's successor will need much greater sensitivity, more in line with the telescopes at major ground-level observatories. The designers are faced with the challenge of building a huge, high-precision optical instrument that assembles and aligns itself, in deep space, without any direct human intervention. The new telescope will be stationed far beyond the reach of astronauts, at a point in space where stray light from Earth and the moon won't be a hazard to its ultrasensitive detectors. The good news is that, like the HST, the images sent back by the new instrument will be posted online for all to see. If the past is any guide, they ought to be spectacular!

## Vocabulary

**black hole** — A dense, compact object whose gravitational pull is so strong that — within a certain distance of it — nothing can escape, not even light. Black holes are thought to result from the collapse of certain very massive stars at the ends of their evolution.

**Big Bang** — The dominant scientific theory about the origin of the universe. According to the big bang, the universe was created sometime between 10 billion and 20 billion years ago from a cosmic explosion that hurled matter in all directions.

**cosmology** — The study of the origin and evolution of the universe.

**galaxy** — A group of hundreds of millions of stars, other objects, gas and dust that is held together in space by gravity. Telescopes such as the HST have revealed billions of galaxies other than our own.

**Edwin Powell Hubble** — (1889–1953) An American astronomer who discovered the existence of other galaxies moving away from one another, leading to the conclusion that the universe is expanding.

**Hubble's Constant** — The mathematical constant that gives the relationship between the velocity of receding galaxies and their distance.

**Hubble Space Telescope** — The first large optical telescope launched above the Earth's atmosphere carrying instruments sensitive to visible and ultraviolet light. The telescope was built by NASA with major contributions from the European Space Agency, and was launched in 1990.

**infrared** — Radiation with slightly longer wavelengths and slightly lower frequencies than those of visible light.

**James Webb Space Telescope (formerly known as the Next Generation Space Telescope)** — A large, near- and mid-infrared optimized space telescope designed to be the successor of the Hubble Space Telescope.

**NASA** — Acronym for the National Aeronautics and Space Administration, a U.S. government agency formed in 1958 with the goal of making space exploration possible.

## Activities & Discussion

- What problems did the Hubble Space Telescope face when it was launched in 1990? How did astronauts fix the problem with the Hubble Space Telescope?
- Why do people say that stargazing is like looking back in time?
- Ask students to explain why a telescope orbiting above the Earth's atmosphere can retrieve images of a better resolution than images taken from earthbound observatories.

## Suggested Internet Resources

Periodically, Internet Resources are updated on our Web site at [www.LibraryVideo.com](http://www.LibraryVideo.com)

- [amazing-space.stsci.edu/whatsnew.shtml](http://amazing-space.stsci.edu/whatsnew.shtml)

"Amazing Space" contains a wealth of online activities, background information on the James Webb Space Telescope and the latest news and images directly from deep space!

*(Continued)*