



The Hubble Space Telescope

AN “EYE” ON THE UNIVERSE

From its position about 350 miles above Earth’s surface, the Hubble Space Telescope has contributed enormously to astronomy. It has expanded our understanding of star birth, star death, and galaxy evolution, has helped move black holes from scientific theory to fact, and has shown that the expansion of the universe is speeding up. Credited with more than 570,000 images and the subject over 7,500 research papers, the space telescope is helping astronomers answer a wide range of intriguing questions about the origin and evolution of the universe.

How the Telescope Works

Hubble’s science instruments serve as astronomers’ eyes on the universe. Once the telescope observes its celestial object, its onboard computers convert the data into long strings of numbers that are beamed down to Earth via communications satellites. The data are then translated into information and pictures, which scientists study. Hubble is equipped with spectrographs and cameras sensitive to ultraviolet, visible, and infrared light.

The Telescope’s Name

NASA named the Hubble Space Telescope for astronomer Edwin P. Hubble, who discovered in 1929 that the universe is expanding. Hubble’s observation — one of the greatest triumphs of 20th-century astronomy — now forms the foundation of the “Big Bang” theory of the creation and evolution of the universe.

VOCABULARY

Spectrograph: An instrument that spreads light into its component colors for detailed study.

Ultraviolet: Radiation with shorter wavelengths and higher frequencies than those of visible light.

Infrared: Radiation with longer wavelengths and lower frequencies than those of visible light.

FAST FACTS

Telescope Statistics

Length: 13.3 m (43.5 ft.)

Diameter: 4.2 m (14 ft.)

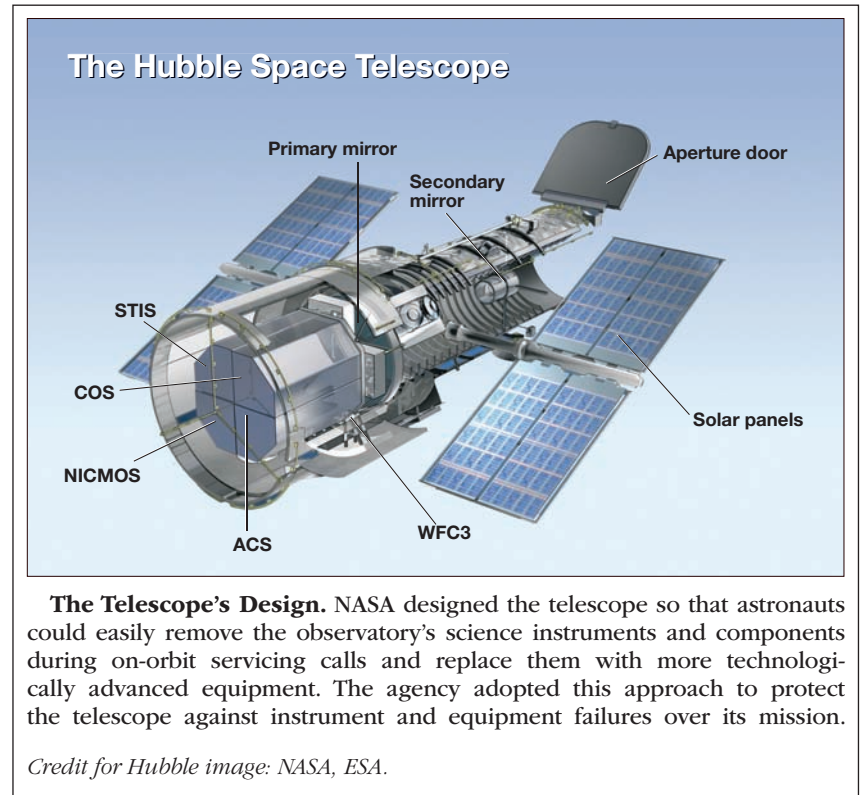
Weight: 11,100 kg (24,500 lbs.)

Orbit: About 564 km (about 350 mi.)/28.5 degrees from the equator

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The Telescope’s Design. NASA designed the telescope so that astronauts could easily remove the observatory’s science instruments and components during on-orbit servicing calls and replace them with more technologically advanced equipment. The agency adopted this approach to protect the telescope against instrument and equipment failures over its mission.

Credit for Hubble image: NASA, ESA.

Instruments

- **Wide Field Camera 3 (WFC3)**
- **Cosmic Origins Spectrograph (COS)**
- **Space Telescope Imaging Spectrograph (STIS)**
- **Near Infrared Camera and Multi-Object Spectrometer (NICMOS)**
- **Advanced Camera for Surveys (ACS)**

Credit for Hubble image: NASA, ESA.

You can get images and other information about the Hubble Space Telescope on the World Wide Web. Visit <http://www.stsci.edu/outreach> and follow the links.

The corresponding classroom activity for this lithograph can be found at: <http://amazing-space.stsci.edu/> or may be obtained by contacting the Office of Public Outreach at the Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218.





In Search of ... Hubble's Science Instruments

Description

Use the “Hubble Space Telescope” lithograph as the initial source of information to engage your students in a Level One Inquiry activity. Students will use the image, diagram, and text on this lithograph to generate questions about the Hubble Space Telescope and its instruments. They will conduct research to answer their questions as well as learn about a Hubble instrument and how it works. This curriculum support tool is designed for use as an introductory activity in a unit that incorporates scientific inquiry or has a technology theme.

About Inquiry-based Learning

The inquiry process is driven by a student's own curiosity, wonder, interest, or passion to understand an observation or to solve a problem. It involves a process of exploring the natural or material world. This exploration prompts students to ask questions and to make discoveries in the search for new insights. A Level One Inquiry activity uses questions and problem-solving methods directed by the teacher. In this activity, teachers use the lithograph images to help students formulate questions about the Hubble Space Telescope and its instruments. Teachers suggest selected resources about the Hubble Space Telescope to help students answer their questions. Students provide supporting evidence for their conclusions. This process can help prepare students to become more independent thinkers. Note: The preparation section below provides resources for inquiry-based learning.

Grade Level

Middle to high school, grades 6–9.

Prerequisites

Students should know that light is a tool that astronomers use to learn about celestial objects. Students also should be aware that space telescopes are located above the Earth's atmosphere.

Misconceptions

Teachers should be aware of the following common misconceptions and should determine whether their students harbor any of them. Students may have misconceptions regarding the Hubble Space Telescope and its instruments. Students might think that the telescope can observe celestial bodies better than other observatories because it is closer to them or because it travels to the celestial bodies.

Vocabulary

Hubble Space Telescope: An orbiting telescope that collects light from celestial objects in visible, near-ultraviolet, and near-infrared wavelengths. (See the lithograph for additional vocabulary terms.)

Purpose

The purpose of this activity is to engage students in a Level One Inquiry activity. Students will gain experience using the Internet to search for information. They will practice the process skills of observing and analyzing. Students also will organize their material and present their findings. They then will reflect on their learning.

Materials

- “Hubble Space Telescope” lithograph.
- Computer with Internet connection for conducting research.

Instructions for the Teacher

Preparation

- Obtain copies of the lithographs for each student. The Hubble Space Telescope lithograph can be found at <http://amazing-space.stsci.edu/capture/hst/preview-hst.php>.
- Preview the Overview page, found at: <http://amazing-space.stsci.edu/eds/overviews/print/lithos/hst.php>. Use the “Related Materials” section to (1) become familiar with inquiry-based learning and/or (2) become familiar with Hubble Space Telescope instruments.
- Bookmark or identify as favorites the following resources that are necessary to complete the classroom activity.

Repair of Advanced Camera for Surveys (SM4): http://www.nasa.gov/mission_pages/hubble/servicing/SM4/main/ACS_R_FS_HTML.html

Advanced Camera for Surveys (ACS): http://hubble.nasa.gov/a_pdf/news/facts/sm3b/fact_sheet_ACS.pdf

Space Telescope Imaging Spectrograph Repair (SM4): http://www.nasa.gov/mission_pages/hubble/servicing/SM4/main/STIS-R_FS_HTML.html

Space Telescope Imaging Spectrograph (STIS): http://hubble.nasa.gov/a_pdf/news/facts/sm3b/fact_sheet_STIS.pdf

Wide Field Camera 3 (SM4): http://www.nasa.gov/mission_pages/hubble/servicing/SM4/main/WFC3_FS_HTML.html

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Cosmic Origins Spectrograph (SM4): http://www.nasa.gov/mission_pages/hubble/servicing/SM4/main/COS_FS_HTML.html

Near Infrared Camera and Multi-Object Spectrometer (NICMOS):
http://hubble.nasa.gov/a_pdf/news/facts/sm3b/fact_sheet_NICMOS.pdf

HubbleSite Instruments section: http://hubblesite.org/the_telescope/nuts_and_bolts/instruments/

Procedure

Before beginning this activity, identify your students' misconceptions about the Hubble Space Telescope and its instruments by having them write down anything they know and understand about this topic. Use those responses to evaluate your students' misconceptions in one of two ways. Have students volunteer their ideas about the telescope. From those ideas, identify their misconceptions and discuss them with the class. An alternative method is to collect your students' written ideas about the Hubble telescope. From those ideas, compile a comprehensive list of their misconceptions and discuss them with the class.

Ask students to study the image on the front and the diagram on the back of the lithograph. Then tell your students to write as many questions as they can about the telescope and its instruments. Collect the questions and group them by common themes. Ask students to read the information on the back of the lithograph. Then ask them if they found the answers to any of their questions. Tell students to select a Hubble instrument and use the Internet to research their questions and information on their selected instrument. The Internet sites listed on the preview page provide a starting point for their research. Tell students how to access other Web sites.

Ask students to prepare presentations in which they answer their questions. Their presentations also should include information about their selected Hubble instrument. This presentation can be in the form of a skit, a story, a graphic organizer, a PowerPoint show, or a written report — any method that conveys a student's understanding of the topic to another student, to a group of students, or to the entire class. Students may work individually or in groups. Ask students to check whether their original questions were answered during their research or from talking with other students. Then ask students if they have any additional questions.

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Instructions for the Student

Your teacher will ask you to write down what you know and understand about the Hubble Space Telescope and its instruments. You may be asked to share this information with the rest of the class. Study the image of the telescope on the front of the lithograph and then look at the diagram on the back. Write down as many questions as you can about what you see in the image and diagram. Read the back of the lithograph to find answers to your questions.

Using your questions as a guide, conduct research on the Internet to find the answers to your questions. Your teacher will also ask you to select a Hubble instrument to research. Your teacher will provide Web sites to use for your research. Your teacher will ask you to create a presentation to demonstrate your understanding of the material you collected through your research. The presentation could be a skit, a story, a graphic organizer, a PowerPoint show, or whatever format that will communicate the information you learned about Hubble and your selected instrument. Your teacher will direct you to work individually or in small groups. You may make your presentation to another classmate, to another group of students, or to the entire class.

Education Standards

Benchmarks on line

<http://www.project2061.org/publications/bsl/online/index.php>

1. The Nature of Technology.

A. Technology and Science.

By the end of the 8th grade, students should know that

- Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.

By the end of the 12th grade, students should know that

- Technological problems and advances often create a demand for new scientific knowledge, and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. The very availability of new technology itself often sparks scientific advances.

Educational Product

Educators & Students

Grades 6–9