



THE STAR★WITNESS



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Special Feature

Preparing for Hubble's Servicing Mission 4 ("SM4")

By NASA's Amazing Space reporters
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LONG BEFORE NASA was formed and the first satellite was launched into space, a young American scientist named Lyman Spitzer, Jr. proposed that a visible light telescope should be placed in space. A space telescope, he wrote, would reveal much clearer images of far-off objects than any ground-based telescope. Ground-based telescopes are hampered by our Earth's atmosphere, which blurs light from stars and makes them appear to twinkle.

Spitzer worked for more than 50 years to make his dream come true. On April 24, 1990, he watched NASA launch the Hubble Space Telescope (HST) into orbit around Earth.

Hubble was not only the first space telescope to snap images in visible light, it also was the first space observatory designed to be serviced in space. Periodic servicing missions,

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IMAGE: NASA

During Servicing Mission 3A ("SM3A"), (December, 1999), two astronauts (at center, attached to the end of the shuttle's arm) replace Hubble's gyroscopes, with Earth as a spectacular backdrop.

During Servicing Mission 3B



▲ **At top:** An astronaut stands beneath one of two new solar panels installed during Servicing Mission 3B (the fourth service visit, in March, 2002).



▲ **Above:** At the end of the SM3B mission, the shuttle crew released HST from the shuttle's cargo bay and snapped this picture of the newly refurbished telescope.

Right: ▶ SM3B payload commander, John Grunsfeld, gives the "thumbs-up" sign. He will return to Hubble as part of the SM4 servicing mission team.



ALL IMAGES: NASA

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scientists believed, would extend the telescope's operating life and would keep the observatory up-to-date. Astronauts visiting the telescope would replace aging parts and would install science instruments with advanced technology.

Astronauts, in fact, have visited Hubble four times during the telescope's 19-year lifetime. Now, NASA is planning another service call to Hubble. The visit, called Servicing Mission 4 ("SM4"), is planned for May 2009. This servicing mission will help keep Hubble operational until at least 2013.

About the telescope

Hubble is about 380 miles (611 kilometers) above Earth, just above our

planet's atmosphere. It is the size of a school bus (43.5 feet, or 13.3 meters long) and weighs more than 12 tons (11,000 kilograms). The telescope's primary mirror is 94.5 inches wide (2.4 meters). Hubble is named after U.S. astronomer Edwin P. Hubble who, early last century, discovered that galaxies are composed of stars and reside outside our Milky Way galaxy. In further observations, Hubble determined that space is expanding.

Hubble gets a tune-up

Astronauts aboard the space shuttle will make several spacewalks to install six batteries, six gyroscopes, and a Fine Guidance Sensor. Normally, Hubble's instruments run on sunlight collected by its twin solar panels, which make the observatory look

like it has wings. The batteries power Hubble's science instruments when the telescope is in Earth's shadow. The gyroscopes help keep Hubble steady as it orbits Earth and allow scientists to point the telescope at celestial targets. Hubble has three Fine Guidance Sensors, which also help in pointing the telescope at objects.

Making Hubble even better

Another part of SM4 is to boost Hubble's scientific power by installing two state-of-the-art science instruments: the Cosmic Origins Spectrograph (COS) and the Wide Field Camera 3 (WFC3).

COS will examine the ultraviolet light streaming from distant objects. The

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Hits from Hubble's "workhorse" camera, WFPC2

Here are only a few of the hundreds of stunning shots taken by WFPC2 over 15 years. The camera that will replace WFPC2, called WFC3, will be more sensitive to light from objects farther away.



IMAGES: **Jupiter:** R. Evans, J. Trauger, H. Hammel and the HST Comet Science Team and NASA; **Spirograph:** NASA and the Hubble Heritage Team (STScI/AURA); **HDF:** R. Williams (STScI), the Hubble Deep Field Team and NASA; **NGC 1512:** NASA, ESA, and D. Maoz (Tel Aviv University and Columbia University); **Supernova remnant:** NASA and the Hubble Heritage Team (STScI/AURA); **Eagle Nebula:** NASA, ESA, STScI, J. Hester and P. Scowen (ASU)

From top left to bottom right:

- Jupiter in the process of being bombarded by fragments of comet Shoemaker-Levy (dark smudges show impacts);
- The Spirograph Nebula, showing the end stage of a Sun-like star;
- A portion of the Hubble Deep Field (HDF), Hubble's landmark view deep into the universe that showed the incredible number and complexity of galaxies there;
- A magnificent spiral galaxy, NGC 1512, encircled by a starburst ring filled with infant star clusters;
- Sheets of debris — the remains of an exploded star (called a supernova remnant) — found in a nearby galaxy;
- Starbirth regions within three pillars of gas and dust in the Eagle Nebula.

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new instrument will allow Hubble to study galaxy formation and the births of stars and planetary systems. COS will complete observations much faster than Hubble's previous spectrograph.

WFC3 will replace Hubble's "workhorse" camera, the Wide Field Planetary Camera 2 (WFPC2), which has been observing celestial objects for 15 years (see photos, page 3). The new camera will greatly improve Hubble's ability to image large and distant objects, such as galaxies and clusters of galaxies, as well as planets in our solar system.

Astronomers will use WFC3 to make wide-field surveys of the distant universe to study how galaxies formed

and evolved from about 2 billion years after the Big Bang to the present. WFC3 will allow Hubble to see objects that are about five times fainter than Hubble's landmark deep view of the cosmos, called the Hubble Deep Field, taken in 1996 with WFPC2.

An American icon

Helping astronomers solve many of the universe's mysteries is nothing new for Hubble. With its sharp vision, Hubble has brought the wonders of the universe to millions of homes worldwide.

Among its jaw-dropping images are elegant-looking galaxies, the shattered pieces of a comet plunging into

Jupiter's atmosphere, and the gaseous remains of exploding stars. Hubble's greatest science contributions include providing clues to how stars are born and die, how galaxies evolve over time, and helping astronomers determine a more exact age for the universe.

With Servicing Mission 4, Hubble will continue to scan the sky, capturing images of space that have made it one of the most celebrated observatories in the history of astronomy. ★

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