National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Hubble's New Optics Probe Core of Distant Galaxy

Wide Field/Planetary Camera I Image
before servicing mission

Wide Field/Planetary Camera II Image
after servicing mission

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On the front: This comparison of images of the core of the galaxy M100 shows the dramatic improvement in Hubble Space Telescope's (HST's) view of the universe. The new image, taken with the second-generation Wide Field/Planetary Camera II (WF/PC II) installed during the STS-61 HST First Servicing Mission, beautifully demonstrates that the camera's corrective optics compensate fully for the optical aberration in the telescope's primary mirror. With the new camera, Hubble will probe the universe with unprecedented clarity and sensitivity and fulfill the most important scientific objectives for which it originally was built.

Front right: The core of the spiral galaxy M100, as imaged by WF/PC II in its high-resolution channel. WF/PC II's modified optics correct for Hubble's previously blurry vision, allowing the telescope, for the first time, to cleanly resolve faint structure as small as 30 light-years across in a galaxy tens of millions of light-years away. The image was taken December 31, 1993.

Front left: For comparison, a picture taken with the WF/PC I camera November 27, 1993, just a few days before the servicing mission. The effects of the optical aberration in HST's 2.4-meter primary mirror blur starlight, smear out fine detail and limit the telescope's ability to see faint structure.

Both Hubble images are "raw," that is, they have not been processed using computer image reconstruction techniques that sharpen aberrated images made before the servicing mission but which degrade the accuracy of the images.

The WF/PC II was developed by the Jet Propulsion Laboratory in Pasadena, California. Hubble is managed by Goddard Space Flight Center in Greenbelt, Md., for the Office of Space Science at NASA Headquarters in Washington, D.C.

The mission to service Hubble was carried out from the Space Shuttle Endeavour, which flew into space December 2, 1993, from Kennedy Space Center in Florida and returned to Earth on December 13. The 11-day mission featured a record five spacewalks to service HST.

Ground-based **WF/PC I** **WF/PC II**

IMAGE COMPARISON SHOWS POWER OF "NEW" HUBBLE
The three panes above show images of a very bright star, Melnick 34, in the giant star-forming region called 30 Doradus in the Large Magellanic Cloud. In the background are a number of fainter stars comparable in luminosity to our Sun.
Above left: The best available ground-based image of Melnick 34.
Above center: The same star imaged by the first Wide Field/Planetary Camera I. Even with its aberrated optics, the advantages of working in space above Earth's distorting atmosphere are immediately apparent.
Above right: The same star imaged by the newly installed Wide Field/Planetary Camera II. The new optics allow for sharper focus and reveal a large number of fainter stars in a crowded field.

For The Classroom*
In this activity, the student's eye is an analogy of the imaging processing computer that stores numerical image fragments, collected and radioed to Earth by the Hubble Space Telescope, and reassembles them for use.

Materials:
Paper tube
Index card
Pencil
Ruler
Scissors
Tape

Procedure:
1. Trace one end of the tube on the index card and cut out the circle.
2. Use the ruler to draw a straight line directly across the diameter of the circle.
3. Cut the circle in half along the straight line.
4. Tape each half of the circle on one end of the tube leaving only a narrow slit about 2 to 3 millimeters wide.
5. Look through the other end of the tube. Try to make out the image of what you are looking at. Slowly move the tube from side to side. Gradually increase the speed of the tube's movement.

Discussion:
This activity roughly demonstrates the imaging process used by the Hubble Space Telescope. By slowly moving the tube from side to side small fragments of the image are captured and directed down the tube ("radioed") towards the student's eye. Because the fragments are quickly forgotten, the addition of many more fragments as the tube continues to move confuses the image in the student's mind. However, as the tube is moved rapidly, each image fragment remains just long enough to combine with the others to form a recognizable image. This effect is known as "persistence of vision."
*From *Classroom Activities* available at NASA Teacher Resources Centers