Core of Galaxy NGC4261

Hubble Space Telescope

Wide Field/Planetary Camera

Ground-Based Optical/Radio Image

HST Image of a Gas and Dust Disk

380 Arc Seconds
88,000 LIGHT-YEARS

17 Arc Seconds
400 LIGHT-YEARS

The image on the left is a ground-based composite optical/radio view of NGC4261, located 45 million light-years away. Photographed in visible light (white), the galaxy appears as a fuzzy disk of hundreds of billions of stars. A radio image (orange) shows a pair of opposed jets emanating from the nucleus and spanning a distance of 88,000 light-years.

The NASA Hubble Space Telescope image (right) shows the giant disk of cold gas and dust fueling a possible black hole at the core of galaxy NGC4261. Estimated to be 300 light-years across, the disk is tipped enough (about 60 degrees) to provide astronomers with a clear view of its bright hub, which presumably harbors the black hole. The dark, dusty disk represents a cold outer region, which moves inward to within a few hundred million miles of the suspected black hole. This disk feeds matter into the black hole, where gravity compresses and heats the material. Some hot gas squirts out from the black hole's near-vicinity to create the radio jets. The jets are aligned perpendicular to the disk, like an axle through a wheel. This provides strong circumstantial evidence for the existence of a black hole "central engine" in NGC4261. The Hubble Space Telescope image was taken with the observatory's Wide Field/ Planetary Camera (WF/PC) in the planetary camera mode.

NASA's Hubble Space Telescope (HST) was launched from the Space Shuttle Discovery in April 1990. No research mission in NASA history has generated higher scientific expectations than HST, designed to be the most powerful astronomical telescope ever built and far surpassing the capabilities of ground-based optical telescopes for many kinds of research. The key to HST success is its operation in space—above the blurring, obscuring and absorbing effects of the Earth's atmosphere.

Two months after launch, scientists and engineers determined that there was an optical defect, or "spherical aberration," in the primary mirror that blurred the telescope's focus. Actions have been taken to alleviate that flaw and, as a result, scientists have made a number of significant discoveries with the observatory.

Designed to be serviced in space and to remain in operation for 15 years, HST is scheduled to undergo its first maintenance in late 1993 or early 1994. Under current plans, Space Shuttle Endeavour (STS-61) will take a team of highly trained astronauts to the observatory, where they are scheduled to make three Extra Vehicular Activity (EVA) spacewalks to service the telescope. The EVA astronauts are Story Musgrave, Tom Akers, Jeff Hoffman and Kathy Thornton.

Included in the servicing plans are replacement of the solar arrays, replacement of the Wide Field/Planetary Camera (WF/PC) with a second generation WF/PC, installation of a Corrective Optics Space Telescope Axial Replacement (COSTAR) instrument designed to correct much of the "spherical aberration" just as eyeglasses correct for the imperfections of human vision, replacement of some gyro assemblies, restoration of on-board computer memory capacity and work on the Goddard High Resolution Spectrograph.

The servicing mission is being managed by the Goddard Space Flight Center, Greenbelt, Maryland.

Credit: Walter Jaffe, Leiden Observatory, The Netherlands; Holland Ford, Johns Hopkins University/Space Telescope Science Institute, and NASA.

For the Classroom

1. What is a black hole? Why do astronomers use words like "possible," "suspected," or "circumstantial evidence" when discussing a black hole? How does a black hole get its name?

2. The core of galaxy NGC4261 is 45 million light-years away. A light-year is the distance (not a unit of time) that light can travel in one year. If the speed of light is 300,000km/s, find the distance light travels in a year. Fill in the blanks:

$$\frac{300{,}000\ \text{km}}{\text{sec}} \times \frac{\text{sec}}{\text{min}} \times \frac{\text{min}}{\text{hr}} \times \frac{\text{hr}}{\text{day}} \times \frac{\text{day}}{\text{yr}} = \frac{\text{km}}{\text{yr}}$$

3. Because light from very distant objects takes so long to reach us, we see these objects as they were in the distant past. The light from our nearest galaxy, Andromeda, takes 2.2 million years to reach Earth. How does being able to see objects as they were in the distant past help astronomers to understand our universe?

4. The basic telescope design of the Hubble Space Telescope is called Cassegrain, after its 17th century inventor.
How does a Cassegrain telescope work?
What are other types of optical telescopes?
Draw a simplified picture of each of the various types of optical telescopes. How are they similar? How do they differ?

5. Illustrate or describe the differences among the following:

constellation	galaxies
globular clusters	open clusters
quasars	supernova

6. Light travels faster than sound. You can use this fact to estimate your distance from a thunderstorm. Count the number of seconds between the flash of lightning and the clap of thunder and divide by five to estimate the number of miles away the lightning struck.