

GOODS/ERS2 FIELD



More than 12 billion years of cosmic history are shown in this unprecedented, panoramic, full-color view of thousands of galaxies in various stages of assembly.

This image, taken by NASA's Hubble Space Telescope, was made from mosaics taken in September and October 2009 with the newly installed Wide Field Camera 3 (WFC3) and in 2004 with the Advanced Camera for Surveys (ACS). The view covers a portion of the southern field of a large galaxy census called the Great Observatories Origins Deep Survey (GOODS), a deep-sky study by several observatories to trace the formation and evolution of galaxies.

The final image combines a broad range of colors, from the ultraviolet, through visible light, and into the near-infrared. Such a detailed multi-color view of the universe has never before been assembled in such a combination of color, clarity, accuracy, and depth.

Hubble's sharp resolution and new color versatility, produced by combining data from the two cameras, are allowing astronomers to sort out the various stages of galaxy formation. The image

reveals galaxy shapes that appear increasingly chaotic at each earlier epoch, as galaxies grew through accretion, collisions, and mergers. The galaxies range from the mature spirals and ellipticals in the foreground, to smaller, fainter, irregularly shaped galaxies, most of which are farther away, and therefore existed farther back in time. These smaller galaxies are considered the building blocks of the larger galaxies we see today.

Astronomers are using this multi-color panorama to trace many details of galaxy assembly over cosmic time, including the star-formation rate in galaxies, the rate of mergers among galaxies, and the abundance of weak active galactic nuclei.

The image shows a rich tapestry of 7,500 galaxies stretching back through most of the universe's history. The closest galaxies seen in the foreground emitted their observed light about a billion years ago. The farthest galaxies, a few of the very faint red specks, are seen as they appeared more than 13 billion years ago, or roughly 650 million years after the Big Bang. This mosaic spans a slice of space that is equal to about a third of the diameter of the full Moon (10 arcminutes).

The new Hubble view highlights a wide variety of stages in the galaxy assembly process. Ultraviolet light taken by WFC3 shows the blue glow of hot, young stars in galaxies teeming with star birth. The orange light reveals the final buildup of massive galaxies about 8 billion to 10 billion years ago. The near-infrared light displays the red glow of very distant galaxies – in a few cases as far as 12 billion to 13 billion light-years away – whose light has been stretched, like a toy Slinky, from ultraviolet light to longer-wavelength infrared light due to the expansion of the universe.

In this ambitious use of Hubble's observing time, astronomers used 96 Hubble orbits to make the ACS optical observations of this slice of the GOODS field and 104 orbits to make the WFC3 ultraviolet and near-infrared exposures. WFC3 peered deeper into the universe in this study than comparable near-infrared observations from ground-based telescopes. This set of unique new Hubble observations reveals galaxies to about 27th magnitude in brightness over a factor of 10 in

wavelength. That's over 250 million times fainter than the unaided eye can see in visual light from a dark ground-based site.

STAR-BIRTH PARTY ALMOST OVER IN NGC 2976



NGC 2976 does not look like a typical spiral galaxy, as this NASA Hubble Space Telescope image shows.

In this view of the oddball galaxy's inner region, there are no obvious spiral arms. Dusty filaments running through the disk show no clear spiral structure. A raucous interaction with a neighboring group of hefty galaxies stripped away some gas and funneled the rest to the galaxy's inner region, fueling star birth about 500 million years ago. At the same time, the galaxy's outer

regions stopped making stars because the gas ran out. Now, the inner disk is almost out of gas as new stars burst to life, shrinking the star-formation region to a small area of about 5,000 light-years around the core.

Astronomers pieced together the galaxy's star-formation story with the help of Hubble's sharp vision. The galaxy's relatively close distance to Earth allowed Hubble's Advanced Camera for Surveys (ACS) to resolve hundreds of thousands of individual stars. What look like grains of sand in the image are actually single stars.

Studying the individual stars allowed astronomers to determine their color and brightness, which provided information about when they formed. Based on this analysis, the astronomers reconstructed the star-making history for large areas of the galaxy.

The blue dots in the image are fledgling blue giant stars residing in the remaining active star-birth regions. NGC 2976 resides on the fringe of the M81 group of galaxies, located about 12 million light-years away in the constellation Ursa Major.

The observation is part of the ACS Nearby Galaxy Survey Treasury (ANGST) program. Data for the image were taken Dec. 27, 2006, to Jan. 10, 2007.