National Aeronautics and Space Administration

THE STAR WITNESS

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Special Feature

The Hubble Space Telescope: Time Machine to the Galaxies

By NASA's Amazing Space reporters
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GALAXIES, GALAXIES everywhere — as far as the Hubble Space Telescope can see. Galaxies are large collections of stars, gas, and dust held together by gravity. The Earth-orbiting observatory looked far back in time to find as many as 10,000 galaxies. Many are different colors, shapes, sizes, and ages. Most of them existed before Earth was born. Some were formed just a short time after the universe was created, some 13.7 billion years ago. This stunning view of the universe is called the Hubble Ultra Deep Field. The image is the farthest view of the universe ever taken in visible light.

How far is far?

Light from these faraway galaxies began traveling to Earth billions

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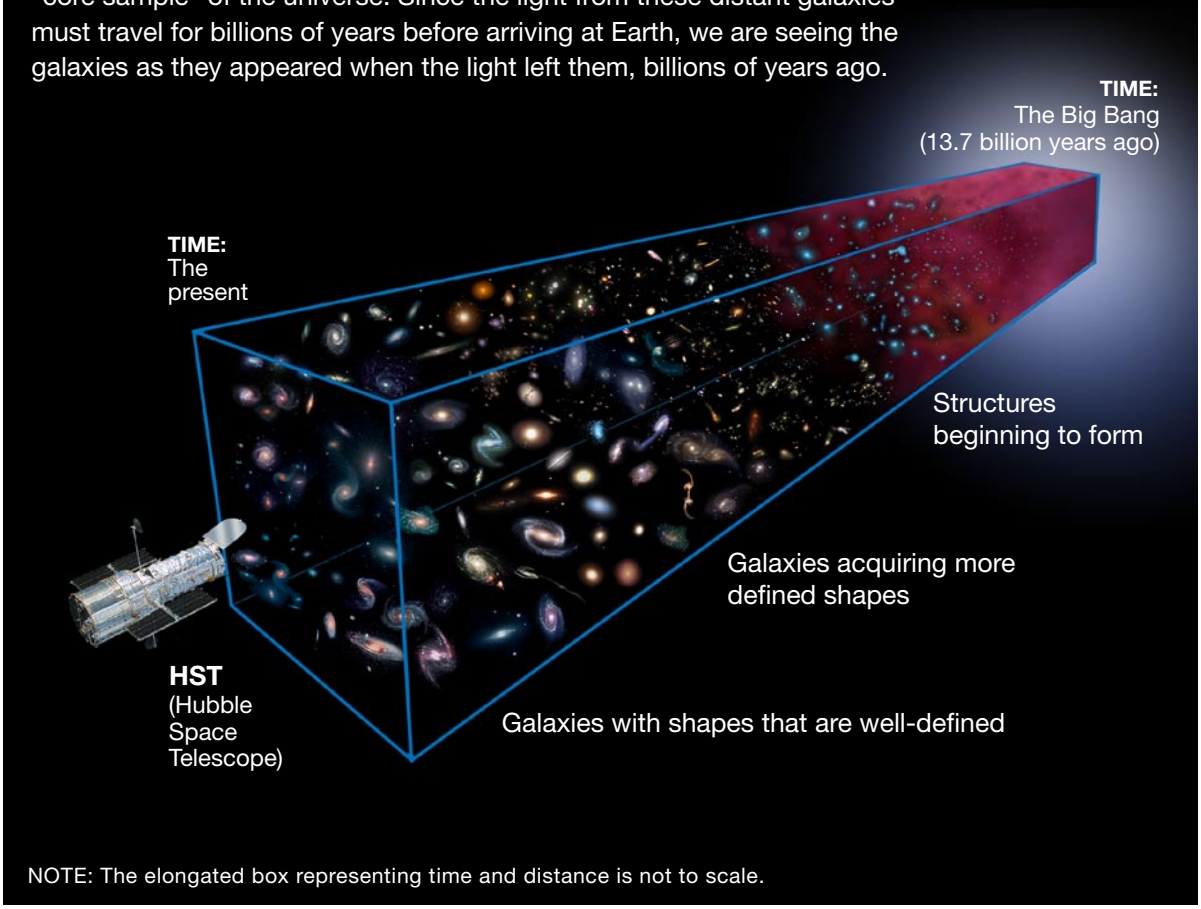
NASA, ESA, S. Beckwith (STScI), and the HUDF Team

The Hubble Ultra Deep Field (HUDF) is the deepest visible-light portrait of the universe ever achieved by humankind. This image reveals nearly 10,000 galaxies. Some formed shortly after the universe itself was born.

HUDF reveals stages of galaxy formation

In the Hubble Ultra Deep Field image, HST looked back in time, through a "core sample" of the universe. Since the light from these distant galaxies must travel for billions of years before arriving at Earth, we are seeing the galaxies as they appeared when the light left them, billions of years ago.



NOTE: The elongated box representing time and distance is not to scale.

STScI Graphic, Ann Didyk

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of years ago, long before humans roamed our planet. On Earth, we see the light from a lamp the moment we turn it on because light travels extremely fast. Light from the distant galaxies in the Hubble Ultra Deep Field travels at the same speed. Those galaxies are so far away, however, that it takes a long time for their light to reach Earth. We see the galaxies, therefore, as they appeared billions of years ago (see illustration above).

How to hook a galaxy

How do astronomers study these very distant galaxies? Imagine standing on a beach, casting for fish in the surf. You catch a few small- and medium-size fish. Now imagine standing on a boat in the middle of the ocean, where the water is a hundred feet deep. Once again, you are casting for fish. You catch more fish, but these fish look different from those you caught on the beach. When you combine both catches, you see fish of many different colors, shapes, sizes, and ages.

Into the deep

Think of astronomers as galactic fishermen. They are casting for the variety of galaxies that reside deeper and deeper in space. To look deeper in space astronomers must use powerful telescopes like the Hubble Space Telescope. As astronomers gaze farther into space, they see younger and younger galaxies. In fact, the galaxies look different the farther back in time the astronomers look. There are no beautiful spiral and elliptical galaxies like those we see in the neighborhood of our Milky Way galaxy. Instead, astronomers see oddly shaped blobs that are the building blocks of galaxies and galaxies that have become distorted from collisions with other galaxies.

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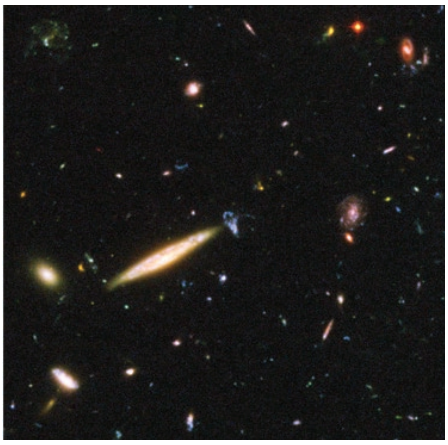
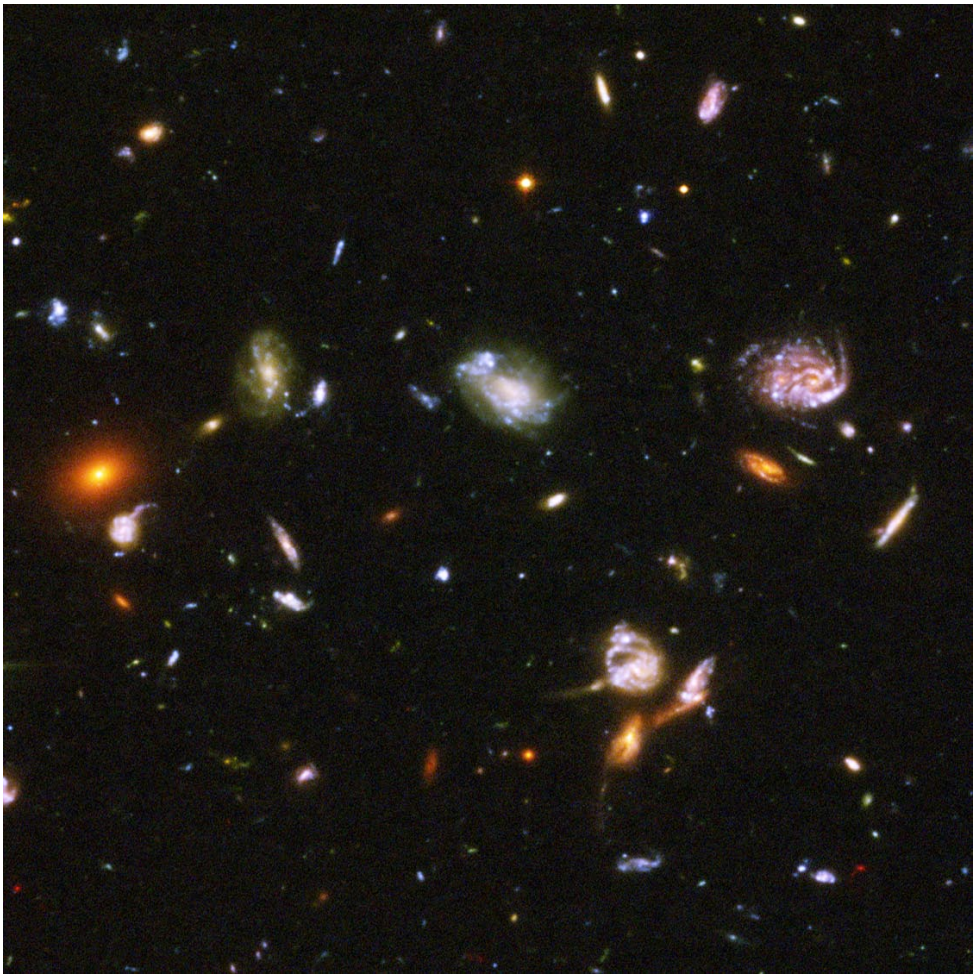
Galaxies shed light on the history of the universe

Astronomers hope to look even deeper in space to a time when there were no galaxies. The absence of galaxies means that the universe was so young that galaxies had not had time to form.

By looking at galaxies stretching farther and farther back in time, astronomers have learned that galaxies change over time. They are putting together the snapshots of galaxies over many different eras so that they can tell a more complete story of how galaxies form and change. This information will help astronomers understand how the universe began and where it is heading.





ALL IMAGES: NASA, ESA, S. Beckwith (STScI), and the HUDF Team

Details from the Hubble Ultra Deep Field

These details show galaxies in a variety of shapes, sizes, and colors.

Above: The three galaxies just below center are having a "tug-of-war" with gravity. Their distorted, oddball shapes are due to this fierce encounter. Three large galaxies in the upper half of the image show spiral features because they have not been distorted from interactions. The faintest, smallest, reddest galaxies in the image may be among the most distant known, appearing here as they were when the universe was 800 million years old.

Top left: The bright orange object with a cross shape is a star. A cross shape is created whenever a star's very bright light travels through the telescope.

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