Hubble Researchers Perplexed by Massive Compact Galaxies in the Early Universe

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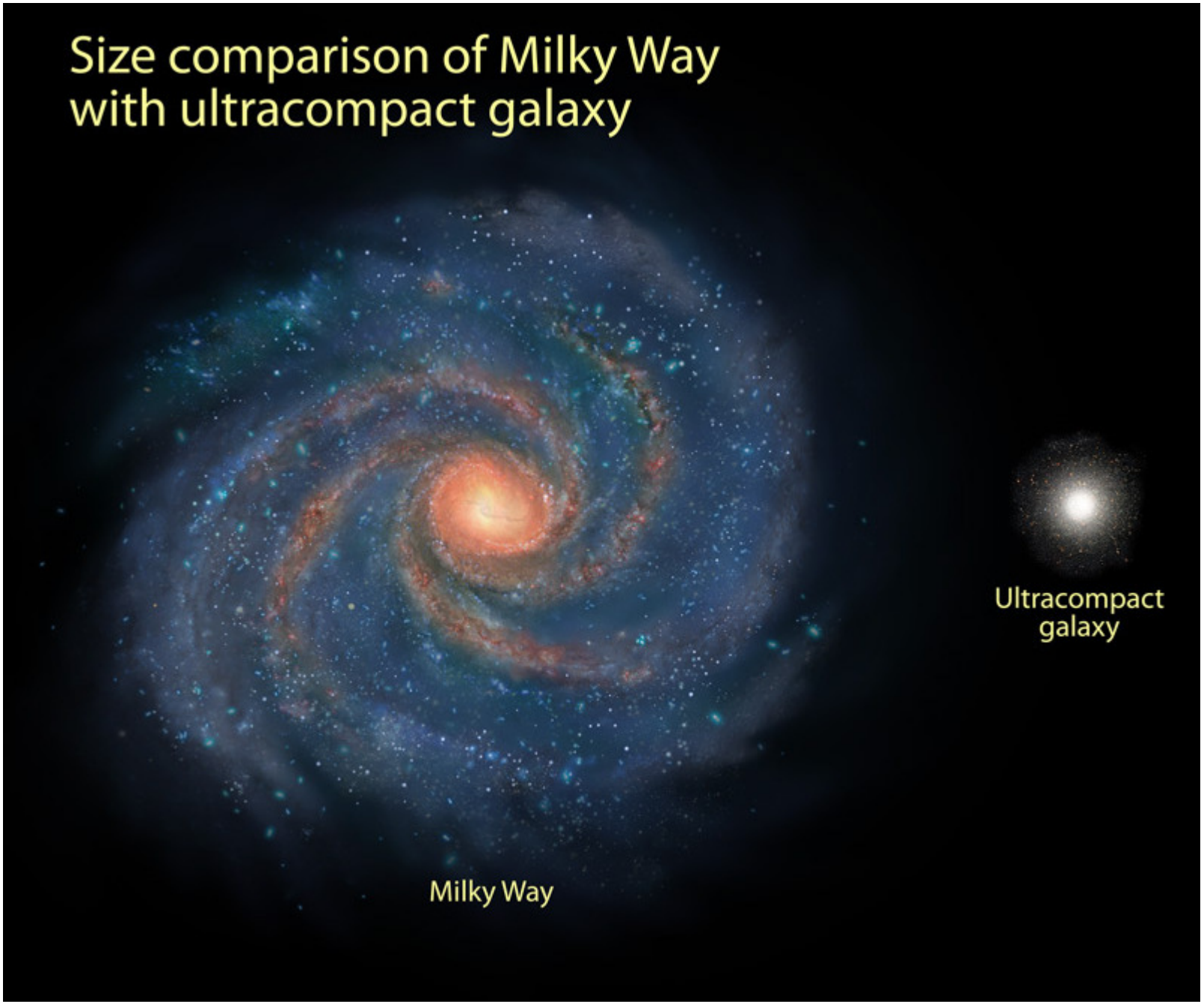

This illustration shows the comparative sizes of our Milky Way Galaxy and an ultracompact galaxy, which existed in the early universe. Although the compact galaxy is only a fraction of the size of our Milky Way, it contains the same number of stars. The

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Astronomers looking at galaxies in the universe's distant past made a perplexing discovery when they found nine young, compact galaxies, each weighing in at 200 billion times the mass of the Sun. The galaxies, each only 5,000 light-years across, are a fraction of the size of today's grownup galaxies but contain approximately the same number of stars. Each galaxy could fit inside the central hub of our Milky Way Galaxy.

Astronomers used NASA's Hubble Space Telescope and the W.M. Keck Observatory on Mauna Kea, Hawaii, to study the galaxies as they existed 11 billion years ago, when the universe was less than 3 billion years old.

"Seeing the compact sizes of these galaxies is a puzzle," said Pieter G. van Dokkum of Yale University in New Haven, Conn., who led the study. "No massive galaxy at this distance has ever been observed to be so compact. It is not yet clear how they would build themselves up to become the large galaxies we see today. They would have to change a lot over 11 billion years, growing five times bigger. They could get

small, dense galaxy could fit inside the central hub of our Milky Way. (Image Credit: NASA, ESA, A. Feild - STScI, and P. van Dokkum - Yale University).

larger by colliding with other galaxies, but such collisions may not be the complete answer."

To determine the sizes of the galaxies, the team used the Near Infrared Camera and Multi-Object Spectrometer on Hubble. The Keck observations were carried out with assistance of a powerful laser to correct for image blurring caused by the Earth's atmosphere. "Only Hubble and Keck can see the sizes of these galaxies because they are very small and far away," van Dokkum explained.

Van Dokkum and his colleagues studied the galaxies in 2006 with the Gemini South Telescope Near-Infrared Spectrograph, on Cerro Pachon in the Chilean Andes. Those observations provided the galaxies' distances and showed that the stars are a half a billion to a billion years old. The most massive stars had already exploded as supernovae.

"In the Hubble Deep Field, astronomers found that star-forming galaxies are small," said Marijn Franx of Leiden University, The Netherlands. "However, these galaxies were also very low in mass. They weigh much less than our Milky Way. Our study, which surveyed a much larger area than in the Hubble Deep Field, surprisingly shows that galaxies with the same weight as our Milky Way were also very small in the past. All galaxies look really different in early times, even massive ones that formed their stars early."

The ultradense galaxies might comprise half of all galaxies of that mass 11 billion years ago, van Dokkum said, forming the building blocks of today's largest galaxies.

How did these small, crowded galaxies form? One way, suggested van Dokkum, involves the interaction of dark matter and hydrogen gas in the nascent universe. Dark matter is an invisible form of matter that accounts for most of the universe's mass. Shortly after the Big Bang, the universe contained an uneven landscape of dark matter. Hydrogen gas became trapped in puddles of the invisible material and began spinning rapidly in dark matter's gravitational whirlpool, forming stars at a furious rate.

Based on the galaxies' masses, which are derived from their color, the astronomers estimated that the stars are spinning around their galactic disks at roughly 890,000 to 1 million miles an hour (400 to 500 kilometers a second). Stars in today's galaxies, by contrast, are traveling at about half that speed because they are larger and rotate more slowly than the compact galaxies.

These galaxies are ideal targets for the Wide Field Camera 3, which is scheduled to be installed aboard Hubble during the Shuttle Servicing Mission in the fall of 2008. "We hope to use the Wide Field Camera 3 to find thousands of these galaxies. The Hubble images, together with the laser adaptive optics at Keck and similar large telescopes, should lead to a better understanding of the evolution of galaxies early in the life of the universe," said Garth Illingworth of the University of California, Santa Cruz, and Lick Observatory.

For more information:

http://hubblesite.org/newscenter/archive/releases/2008/15/full/