Survey Reveals Building Block Process For Biggest Galaxies

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A new study of the universe's most massive galaxy clusters shows how mergers play a critical role in their evolution. Astronomers used the twin Gemini Observatory instruments in Hawaii and Chile, and the Hubble Space Telescope to study populations of stars in the universe's most massive galaxy clusters over a range of epochs - the earliest being nearly 7 billion years old, or half the age of the universe.

The team used the Hubble images to map the light distribution of the galaxies in the cluster. Data from the Gemini Multi-Object Spectrograph allowed the team to analyze the light from galaxies to determine their masses, ages and chemical compositions.

"We still don't have a clear picture of how galaxies develop over the history of the Universe, said team leader Jordi Barr of Oxford University. "The strength of this study is that we are able to look at galaxy clusters over a range of epochs."

Barr presented some of the first results of the Gemini/HST Galaxy Cluster Project at a meeting of the Royal Astronomical.

Galaxy clusters contain the most massive galaxies in the universe, but until recently astronomers thought all galaxies in the centers of clusters formed rapidly and then aged without any further changes to their structure in a process known as passive evolution. Results from the Gemini/HST Galaxy Cluster Project show this cannot be the case.

"When we're looking at the most distant galaxy clusters, we are looking back in time to clusters that are in early stages of their formation," Barr said. "The young galaxies in distant clusters appear to be very different from those in the mature clusters that we see in the local Universe."

Barr said his team discovered that the earliest galaxy clusters display a huge variation in their abundances of elements such as oxygen and magnesium, while the chemistry of galaxies in the sample of closer clusters appears to be much more homogenous.

"This difference in chemistry proves that the clusters must actively change over time," Barr said. "If the galaxies in the old clusters have acquired a complete set of elements, it's most likely that they have formed from the mergers of several young galaxies."

The team found star formation is most dependent on galactic mass, and in lower-mass galaxies star formation continues longer. The most massive galaxies in clusters appear to have formed all their stars by the time the universe is just over 1 billion years old, while lower-mass galaxies finish forming their stars some 4 billion years later.

"We see the effects of star-formation in low-mass galaxies, but are unsure about why it's happening," Barr said. "It's possible that star-formation can be shut down very rapidly in dense environments and that the lower-mass galaxies are recent arrivals that are forming stars over a longer period outside the cluster, then falling in - but we are still speculating."

The observations of merging galaxy clusters showed a large proportion of the galaxies in those clusters have undergone recent bursts of star formation. This indicates star formation may be triggered if galaxies are thrown, during the course of a merger, into contact with the gaseous medium pervading the cluster.

The team plans more observations at X-ray wavelengths to study the interactions between galaxies and the distribution and temperature of the surrounding gas.