Astronomers find distant galaxy cluster to shed light on early universe

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A decade ago, Houston businessman and philanthropist George P. Mitchell was so certain there were big discoveries to be made in physics and astronomy and that they should come out of Texas A&M University, he put money on it, endowing the George P. and Cynthia Woods Mitchell Institute for Fundamental Physics and Astronomy to bring the world's most eminent minds in physics and astronomy to Aggieland.

Last June that investment paid off when an international collaboration featuring Texas A&M astronomers Dr. Kim-Vy Tran and Dr. Casey Papovich gathered at Mitchell's Cook's Branch Conservancy (a picturesque 6,000-acre preserve in the east Texas Pineywoods northwest of Houston) for a team brainstorm that recently resulted in the breakthrough discovery of the most distant galaxy cluster found to date.

"This discovery was actually made at Cook's Branch this past June," Tran says. "We were just starting to analyze the data, and Lee [Spitler] had just found this object, so we started talking about it that day."

Galaxy clusters, known as the "urban centers" of the universe, today may contain thousands of galaxies and are viewed as important building blocks with the power to unlock the mysteries of galaxy evolution and conditions in the universe's earliest moments. Tran notes this cluster is located 10.5 billion light-years away from our own Milky Way galaxy and is made up of a dense concentration of 30 galaxies that is the seed for a much bigger "city."

"Our galaxy cluster is observed when the universe was only three billion years old," says Spitler, an astrophysicist at Swinburne University of Technology in Australia and lead author of the team's study, known as the FourStar Galaxy Evolution Survey (Z-FOURGE). "This means it is still young and should continue to grow into an extremely dense structure containing many more galaxies."

The team's findings, funded in part through the National Science Foundation, will be published in the Astrophysical Journal Letters.

Much like Mitchell's vision of Texas A&M as a diamond in the rough, the Z-FOURGE team likewise discovered their recent find hidden in plain sight — essentially the middle of one of the most well-studied regions in the sky. Located near the star constellation Leo, Spitler notes this region has been carefully examined for thousands of hours using all major observing facilities on the ground and in space, including nearly one month of observing time from the Hubble Space Telescope.

Papovich credits the team's discovery to solid science and analysis armed with modern technology — in this case, a new camera built by Z-FOURGE collaborators at Carnegie Observatories. The camera, dubbed FourStar and installed in December 2010 on the Magellan 6.5-meter telescope in Chile, features five specially designed infrared filters that deliver an unprecedentedly precise combination of wavelength resolution and low-light sensitivity, thereby enabling the team to accurately measure the distances to thousands of different galaxies at a time, including those too faint to be detected through previous methods.

"Most other surveys were just looking at the tip of the iceberg," Tran explains. "The modern technology contained in this camera enabled us to detect the faintest light possible, allowing us to see much more of the iceberg than previously revealed.

"It's like we're using a comb to sift through the very distant universe. The combination of filters and depth provided by this camera give us the equivalent of more teeth, resulting in better measurements and more accurate results."

From the first six months of the survey, the team obtained accurate distances for faint galaxies across a region about one-fifth the size of the Moon as seen from Earth. Though the area is relatively small, they found roughly a thousand galaxies more than 10.5 billion light-years away.

"These new filters are a novel approach; it's a bit like being able to do a CAT scan of the sky to rapidly make a 3-D picture of the early universe ," says Swinburne's Karl Glazebrook, who is leading the Australian component of the international collaboration formed in 2009.

The Z-FOURGE survey is led by Dr. Ivo Labbe at Leiden Observatories in The Netherlands.

"These are the first steps of accurately measuring the rate at which these large urban cities formed in a dark-matter-dominated universe," Papovich says. "The rate at which they come together tests our understanding of how structures in the universe formed.

"The broader the timeline, the better our chances of being accurate. Instrumentation is key, and as it evolves, we'll keep pushing the boundaries."

More information: For more information on the Z-FOURGE collaboration and their results, go to z-fourge.strw.leidenuniv.nl/index.html

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