Small distant galaxies host supermassive black holes

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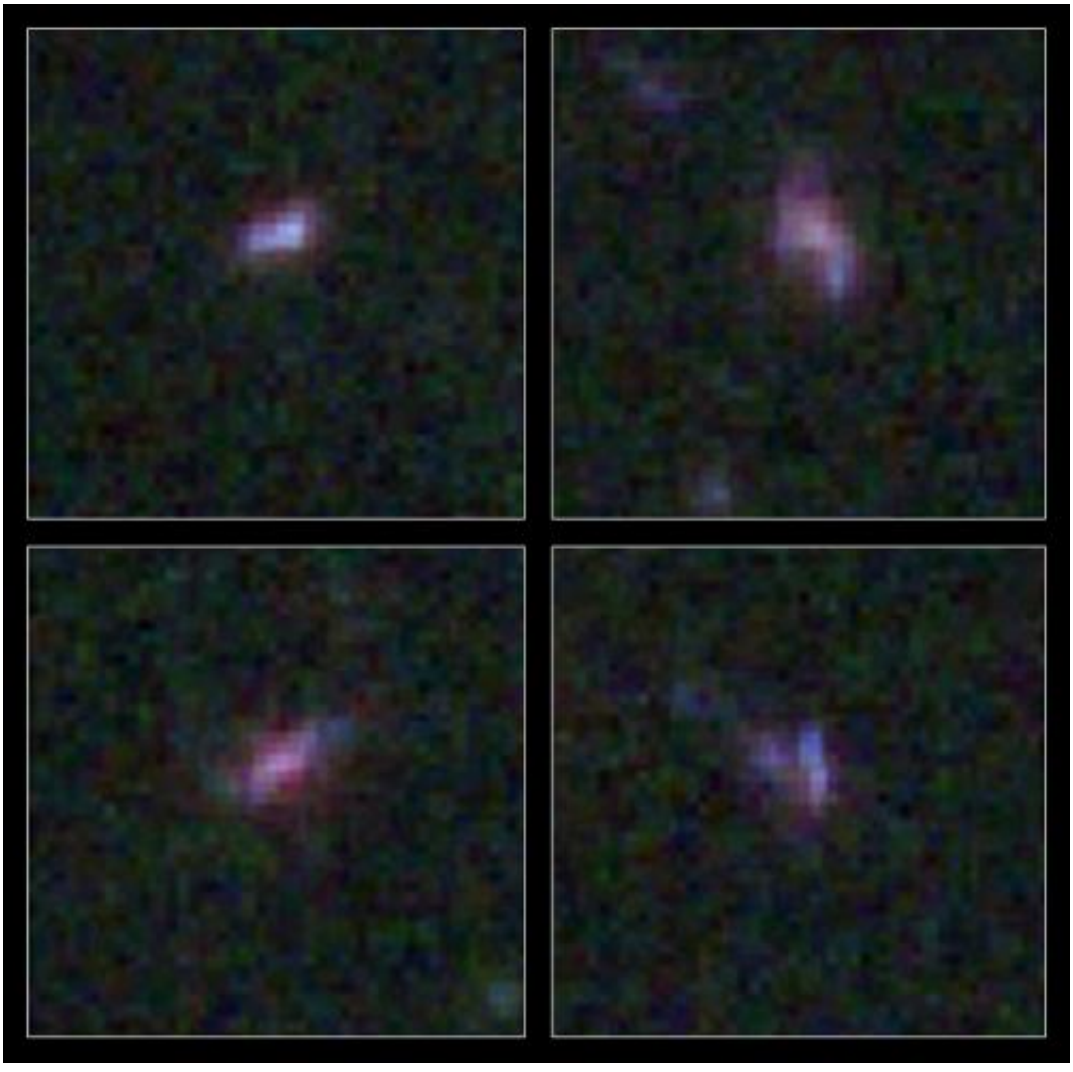

This is a montage of four small, young galaxies taken from a Hubble Space Telescope Wide Field Camera 3 slitless grism sample of 28 low-mass galaxies located 10 billion light-years away in the Hubble Ultra Deep Field region of the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey

(CANDELS). (Credit: NASA; ESA; A. Koekemoer, STScI; J. Trump and S. Faber, University of California, Santa Cruz; and the CANDELS Team)

(PhysOrg.com) -- Using the Hubble Space Telescope to probe the distant universe, astronomers have found supermassive black holes growing in surprisingly small galaxies. The findings suggest that central black holes formed at an early stage in galaxy evolution.

"It's kind of a chicken or egg problem: Which came first, the supermassive black hole or the massive galaxy? This study shows that even low-mass galaxies have supermassive black holes," said Jonathan Trump, a postdoctoral researcher at the University of California, Santa Cruz. Trump is first author of the study, which has been accepted for publication in the Astrophysical Journal and is currently available online.

All massive galaxies host a central supermassive black hole, which may shine brightly as an active galactic nucleus if the black hole is pulling in nearby gas clouds. In the local universe, however, active black holes are rarely seen in small "dwarf" galaxies. The galaxies studied by Trump and his coauthors are about 10 billion light-years away, giving astronomers a view of galaxies as they appeared when the universe was less than a quarter of its current age.

"When we look 10 billion years ago, we're looking at the teenage years of the universe. So these are very small, young galaxies," Trump said.

The study, part of the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDELS), used a powerful new instrument on the Hubble Space Telescope. The "slitless grism" on Hubble's WFC3 infrared camera provided detailed information about different wavelengths of light coming from the galaxies. Spectroscopy

allows researchers to spread out the light from an object into its component colors or wavelengths. With Hubble's high spatial resolution, the researchers were able to get separate spectra from the center and the outer part of each galaxy. This enabled them to identify the tell-tale emissions from a central black hole.

"This is the first study that is capable of probing for the existence of small, low-luminosity black holes back in time," said coauthor Sandra Faber, University Professor of astronomy and astrophysics at UC Santa Cruz and CANDELS principal investigator. "Up to now, observations of distant galaxies have consistently reinforced the local findings--distant black holes actively accreting in big galaxies only. We now have a big puzzle: What happened to these dwarf galaxies?"

One possibility is that at least some of them are the progenitors of present-day massive galaxies like the Milky Way. "Some may remain small, and some may grow into something like the Milky Way," Trump said.

But according to Faber, both possibilities raise further questions. To become big galaxies today, the dwarf galaxies would have to grow at a rate much faster than standard models predict, she said. If they remain small, then nearby dwarf galaxies should also have central black holes. "There might be a large population of small black holes in dwarf galaxies that no one has noticed before," Faber said.

Trump noted that the distant dwarf galaxies are actively forming new stars. "Their star formation rate is about ten times that of the Milky Way," he said. "There may be a connection between that and the active galactic nuclei. When gas is available to form new stars, it's also available to feed the black hole."

In addition to the Hubble observations, the researchers obtained further

evidence of active black holes in the galaxies from x-ray data acquired by NASA's Chandra X-ray Observatory. The study focused on 28 galaxies in a small patch of sky known as the Hubble Ultra Deep Field. Because each object was so small and faint, Trump combined the data from all 28 galaxies to improve the signal-to-noise ratio.

"This is a powerful technique that we can use for similar studies in the future on larger samples of objects," Trump said.

Provided by University of California - Santa Cruz