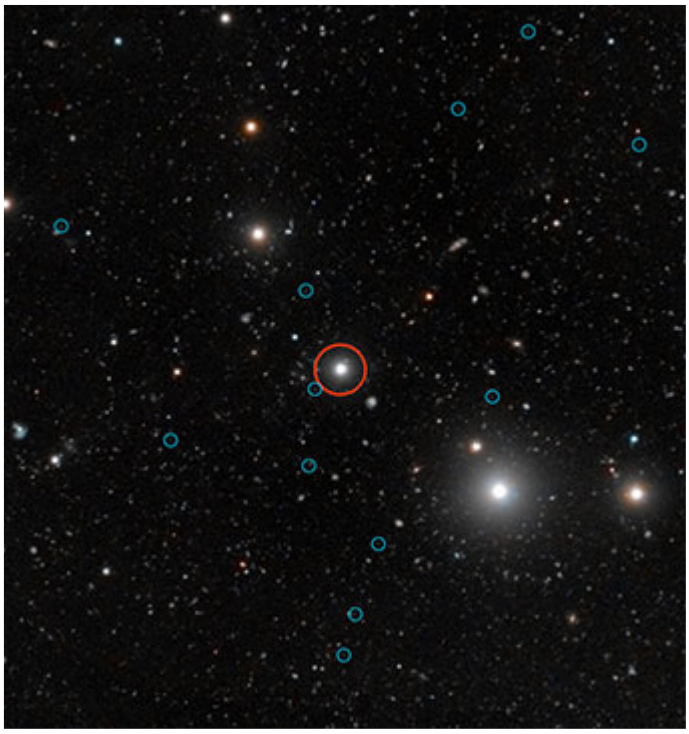
Seeing "Dark" Galaxies

After years of failure, astronomers have finally succeeded in imaging primeval clouds of gas like those that existed before there were stars.



The quasar at the center of the image (circled in red) illuminates dark galaxies (circled in blue) in its neighborhood. The galaxies are "dark" because they're starless, but they fluoresce faintly under the quasar's brilliant light.
ESO / Digitized Sky Survey 2 / S. Cantalupo (UCSC)

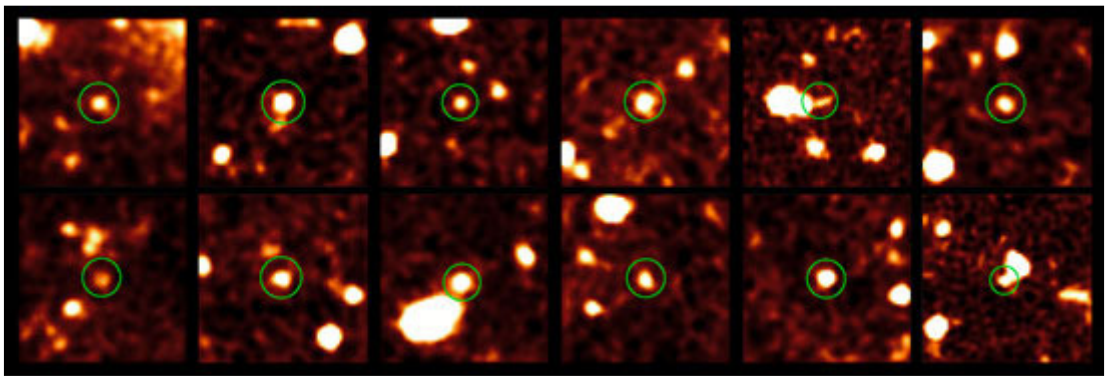
The universe used to be a dark place. Clumps of hydrogen and helium gas filled space; so did clumps of dark matter, the mysterious stuff that makes up most of the universe's mass. Astronomers have long supposed that gravity pulled primordial overdensities of stuff into the blobs that formed the first galaxies. But neither neutral gas nor dark matter shine, and in smaller, less dense clouds, stars haven't had a chance to ignite. So until recently astronomers had no way of detecting these crucial building blobs to test theories of galaxy formation.

Now astronomers are illuminating these "dark" primeval gas clouds using the brilliant ultraviolet light from quasars, distant searchlights powered by supermassive black holes. Sebastiano Cantalupo (University of California, Santa Cruz) and his colleagues proved this technique can work by observing glowing clouds around a quasar, whose light took 10.9 billion years to reach one of the 8.2-meter scopes of the Very Large Telescope array in Chile.

"The light from the quasar makes the dark galaxies light up in a process similar to how white clothes are illuminated by ultraviolet lamps in a night club," study coauthor Simon Lilly (ETH Zurich) explains in an ESO press release.

This process is called fluorescence: when a hydrogen atom in the gas cloud absorbs the quasar's ultraviolet light, it later emits light with a specific, longer wavelength of 121.6 nanometers. The wavelength stretches as the light travels across expanding space to reach Earth, so that by the time it reaches us the light is observed as a shade of violet.

Cantalupo and his colleagues found 98 sources glowing this particular shade of violet around the distant quasar. Since some of these sources might produce light on their own by forming stars, the team carefully analyzed the data to eliminate star-forming sources. They were left with 12 likely "dark galaxies" — dense, starless clouds of gas fluorescing in the quasar's light.



Zoom-in views of the 12 dark galaxies (circled in green) discovered by Cantalupo and his colleagues. Though they lack stars, they're faintly illuminated by the quasar's light.
ESO / Digitized Sky Survey 2 / S. Cantalupo (UCSC)

Until now studying galaxy formation has been a bit of a puzzle because astronomers could not observe the initial ingredients that ultimately go into forming galaxies bursting with stars.

"It is a bit like studying human populations without ever having seen a pregnant woman," says Paul Francis (Australian National University), a quasar researcher not involved in the study. "This is a new technique and as it is developed, it should tell us a lot about where galaxies come from."

Both Francis and other astronomers have tried using the quasar technique to detect dark galaxies before, but only with the VLT scope's sensitivity, very long exposure times, and advances in blue-sensitive imaging has the technique become viable.

The 12 clouds found by Cantalupo's team are already teaching astronomers about the process of galaxy formation. Each gas clump is as massive as a billion Suns, but the clouds are so small and diffuse that turning their gas into stars would take 100 billion years — a rate 200 times lower than typical, massive star-forming galaxies of roughly the same age. As these smaller clouds collide, their densities would go up, eventually gathering enough material together to form galaxies. At that point, the blobs' mostly unused gas reserves would provide the material the galaxy needs for star formation.

Posted by Monica Young, July 17, 2012