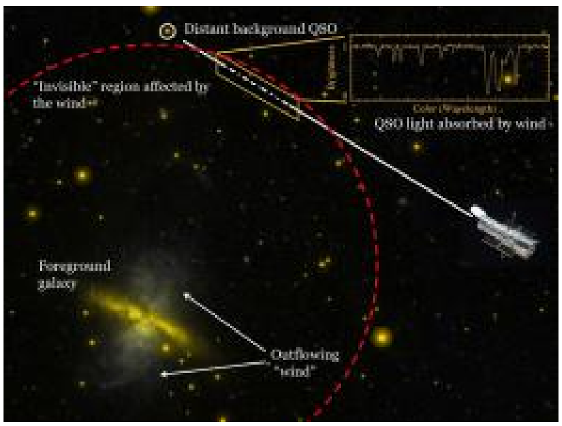
Gaseous halos of galaxies are much larger, more massive than the distribution of stars within the galaxy

November 17 2011



The illustration shows how quasistellar object (QSO) absorption lines are used to study the vast (and effectively invisible) gaseous halos of galaxies. When the light from a distant QSO passes through the gas surrounding a foreground galaxy (schematically indicated with a red dashed circle), some of the colors of the QSO light are absorbed by the foreground material. Consequently, the Hubble Space Telescope observes that some of the colors are "missing." By studying the absorbed colors, astronomers can determine many things about the gaseous halo, such as composition, temperature, density and mass. This technique has revealed that the gaseous halos of galaxies as much larger and more massive than the distribution of stars within the galaxy. These large halos are produced by "winds" of matter rapidly moving away from the galaxies. Courtesy of Todd M. Tripp, UMass Amherst and NASA Galaxy Evolution Explorer

New, high-precision equipment orbiting Earth aboard the Hubble Space Telescope is now sending such rich data back to astronomers, some feel they are crossing the final frontier toward understanding galaxy evolution, says Todd Tripp, leader of the team at the University of Massachusetts Amherst.

Galaxies are the birthplaces of stars, each with a dense, visible central core and a huge envelope, or halo, around it containing extremely low-density gases. Until now, most of the mass in the envelope, as much as 90 percent of all mass in a galaxy, was undetectable by any instrument on Earth.

But Hubble's sensitive new Cosmic Origins Spectrograph (COS), the only one of its kind, has dramatically improved the quality of information regarding the gaseous envelope of galaxies, Tripp says. This huge gain in precision is one of the enormous accomplishments of the COS mission. "Even 10 years ago, most of the mass of a galaxy was invisible to us and such detailed investigations were impossible." the UMass Amherst astronomer points out. "With COS, in a sense we now have the ability to see the rest of the iceberg, not just the tip. This is a very exciting time to be an astronomer."

Tripp, postdoctoral researcher Joe Meiring and theoretical astronomer Neil Katz are co-authors of several companion articles reporting advances in understanding galaxy evolution based on the new COS data in the Nov. 18 issue of *Science*. Other lead investigators are Nicolas Lehner of the University of Notre Dame and Jason Tumlinson of the Space Telescope Science Institute, Baltimore.

"With the new spectrograph we can see galaxy halos out to at least 150,000 parsecs," says Tripp. One kiloparsec is about 19 trillion miles. "Where once we saw only the framework we are now getting a more complete picture, including the composition and movement of gases in the envelope, varying temperatures in different locations and the chemical structure, all in incredible detail," Tripp adds.

In particular, data on the chemical composition and temperature in the gas clouds allow the astronomers to calculate a galaxy's halo mass and how the gaseous envelope regulates the galaxy's evolution.

Another overall mission focus is to explore how galaxies gather mass for making stars. The astronomers have found that heavy elements in the envelopes surrounding the most vigorous star-forming galaxies continuously recycle material, as supernovae explode and shoot hot gas for trillions of miles. Faster-moving material escapes the envelope, but slower- moving particles collapse back into the center and restart the cycle.

Tripp and his UMass Amherst team specialize in studying how the fast-moving gases and matter from exploding supernovae circulate in galaxies. It was a surprise to discover how much mass extends far outside each galaxy, he says. "Not only have we found that star-forming galaxies are pervasively surrounded by large halos of hot gas," says Tripp, "we have also observed that hot gas in transit. We have caught the stuff in the process of moving out of a galaxy and into intergalactic space."

Further, the speed at which gases are moving in different parts of a galaxy is critical. Slower speeds may mean cooling gases, ready to collapse back into the core. Hotter gases are likely expanding and might escape the envelope.

Because the light emitted by this hot plasma is so faint that it is effectively invisible, astronomers use a trick to illuminate it from behind, like studying a misty fog bank by looking through lighthouse beams. In this case the lighthouse is usually a quasar, a super bright object behind the galaxy of interest. Gathering several sightings through the fog, scientists can piece together a map of the gaseous envelope.

Certain wavelengths of light emitted by the quasar are absorbed by the ions in a galaxy's envelope. With COS, a whole new area of the electromagnetic spectrum has become visible. To learn more, Tripp and colleagues also calculate concentrations of the many elements such as hydrogen, oxygen, sulfur, carbon and neon in the envelope, plus up to five ions of each. One of the neon ions has turned out to be particularly important.

"In detecting the neon ions we find that there's a lot of gas at several hundred thousand degrees Kelvin, which we've never been able to see unambiguously before," says Tripp. "It means we can characterize the total mass distribution in the envelope, setting more precise constraints on the temperatures overall. We can now access more diverse ions, and we have new leverage on determining whether stuff is heating up or cooling off. We're gaining new insights."

The neon ion will also play a role in testing theoretical models of galaxy evolution. Theorists including Katz at UMass Amherst construct model galaxies on a computer, simulating its make-up and how it evolves over time. Tripp says, "Now we have hard data to plug into the model and test their ideas. They've got a lot of detailed predictions we can now compare to the real universe. It's a new day for all of us."

Provided by University of Massachusetts at Amherst

Citation: Gaseous halos of galaxies are much larger, more massive than the distribution of stars within the galaxy (2011, November 17) retrieved 9 April 2024 from
https://phys.org/news/2011-11-gaseous-halos-galaxies-larger-massive.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.