Signs of First Intergalactic Hydrogen Cloud Spotted

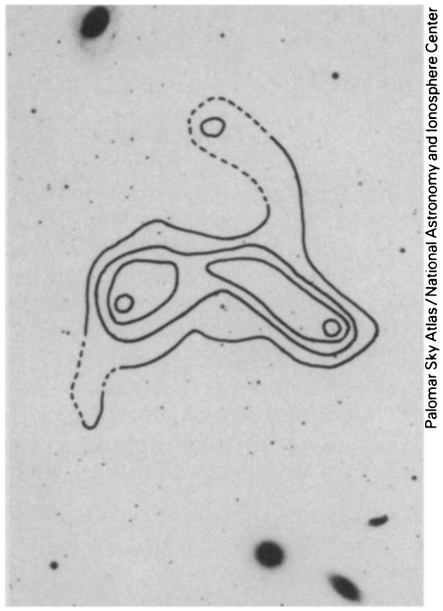
Serendipity has led a team of Cornell University radioastronomers to discover the first evidence for a cloud of neutral hydrogen gas in the vast gulfs between galaxies. The cloud, floating in intergalactic space previously thought empty, could be a "proto-galaxy" that has never formed stars, according to Yervant Terzian, chairman of Cornell's department of astronomy and one of the members of the team that made the discovery. If this is so, say some astronomers, it could have great significance for astrophysicists who are studying the poorly understood process of galactic evolution.

The cloud's presence may also re-ignite the controversy over the universe's "hidden mass." Some theorists believe this as-yet-undiscovered matter's gravitational pull will cause the universe to contract onto itself instead of forever continuing to expand as it is now.

Terzian, Stephen Schneider, George Helou and Edwin Salpeter, all of Cornell in Ithaca, N.Y., were originally studying hydrogen gas clouds within other galaxies, using the 1,000-foot radio telescope at Arecibo, Puerto Rico. They were calibrating the telescope between measurements against a blank spot in the sky, an area where there should have been no measurable radio emissions, when Schneider picked up radio signals that turned out to be from the edge of the cloud. The team then measured the cloud's motion and mapped its radio emissions.

"The cloud is rotating at 80 kilometers per second at its extremities," said Terzian, but this velocity varies from one end of the cloud to the other. It is 10 megaparsecs or about 30 million light-years distant. (One light-year is about six trillion miles.) The hydrogen gas in the cloud is a billion times as massive as the sun, and extends 300,000 light-years in length, about three times that of our galaxy. However, the scientists have observed that the cloud is rotating so rapidly that there must be some "invisible mass" within the cloud whose gravitational pull holds the cloud together. The invisible mass could be 100 times more massive than the cloud itself, making the whole system about as massive as an average star-filled galaxy. The astronomers speculate that the cloud's invisible mass could be in the form of black holes, nonradiating "low-mass stars," or swarms of elementary particles such as massive neutrinos.

Terzian said that others "have looked at intergalactic space before and they have put limits on the amount of hydrogen that might be found there," but no one has found convincing evidence of intergalactic hydrogen other than haloes or streamers coming from galaxies. This cloud is roughly equidistant between two groups of galaxies in the constellation Leo.



Palomar Sky Atlas / National Astronomy and Ionosphere Center

A map of radio emissions from neutral hydrogen in the cloud. Galaxies are in the upper left and lower right.

Morton Roberts, director of the National Radio Astronomy Observatory in Charlottesville, Va., believes the discovery may be important "if it is indeed an isolated cloud." The team, he says, should furnish stronger evidence that the cloud is unconnected to the nearby galactic groups, since gravitational "tidal effects will pull [gas] out of galaxies when two galaxies pass by each other." Cornell's Schneider cautions that they must still prove the cloud is not a tidal fragment, and that it is also a little early to assume that this is primordial material.

The cloud is a "potentially significant" discovery, says Jeremiah Ostriker, chairman of Princeton University's astrophysics department, providing there are no visible stars in the cloud obscured by particles in our own galaxy. The Cornell team checked the location in the Palomar Sky Atlas, a definitive catalog of sky objects, and found nothing certain. Nonetheless, both Roberts and Ostriker believe the next step will be for optical astronomers to reexamine that part of the sky for a visible galaxy by taking "deep plates," extremely sensitive exposures. "Intergalactic clouds" have been reported before and turned out to be galaxies. This evidence, however, is more convincing than before for an intergalactic cloud, Roberts says. If confirmed, the discovery would be "a little like finding a Stone Age culture alive today," Ostriker says. "If we can find a proto-galaxy with . . . gas and dark matter [interstellar dust] it would tell us a lot about how galaxies evolve."

Lloyd Motz of Columbia University agrees that "it is a very interesting discovery for how stars are formed." However, he dismisses the notion that intergalactic gas clouds can provide the necessary "hidden mass" to keep the universe from expanding forever through its gravitational attraction. "There's just not enough [matter] around. You need about 30 to 100 times the mass now present in stars. If there were enough of this material between galaxies, they would be gravitationally distorted, but we don't observe this."

Terzian is not commenting on the universe's hidden mass and its relationship to intergalactic gas. He only says, "We think the universe is homogeneous enough that many other clouds exist and we are embarking on a search for them." —*A. Chen*

Reflections of a rubber mirror

Lockheed

Turbulence in the atmosphere distorts light and so limits the resolution, that is, the sharpness of the images, of ground-based telescopes. Among several schemes to get around this limit is the "rubber" mirror shown here, developed by Lockheed Palo Alto Research Laboratories, which can change its shape continually to compensate for changes in the atmosphere. It consists of 19 hexagonal segments mounted on piezoelectric pistons (pistons made of crystals that change their shape in response to electric signals). These pistons respond to a servomechanism that monitors the incoming light and sends commands to adjust each mirror segment to an optimum position for good resolution. The mirror was successfully tested during January at Sacramento Peak Observatory in New Mexico.