“Pressure on Galaxies in Clusters Measured for First Time”

Who would have guessed that, as galaxies move through the vast emptiness of space, they push material out of their way as they go, much as a meteor plunging through Earth’s atmosphere pushes molecules of air to the side? And, who would have guessed that at the same time, the outer gas layers of those galaxies are ripped away?

But, galaxies don’t push air; instead, they collide with the intracluster medium (ICM), the gas and dust that exists between galaxies within galaxy clusters. As a galaxy plows its way through the universe, its leading edge experiences a kind of pressure, called “ram pressure.” (In general, ram pressure is the pressure experienced by a body moving through a fluid medium.) If the ram pressure is strong enough, it can remove gas from the affected galaxies, and render them unable to give birth to stars. Now, a team of researchers believe they have found a way to measure ram pressure, and the Spitzer Space Telescope has been an important part of the discovery.

“We think that, for the first time, we may have a way to measure the strength and direction of ongoing ram pressure, “ says Eric Murphy, one of the astronomers on the team, and a post-doctoral scholar at Caltech.

Murphy and the other astronomers figured out a way to measure ram pressure by comparing measurements from two different instruments. First, they used infrared data from Spitzer’s Multiband Imaging Photometer to create model maps of ten galaxies within the Virgo Cluster. Then, they compared those maps to maps created using data from radio continuum -- low-frequency -- measurements collected by the Very Large Array, located in New Mexico. (The Very Large Array is a collection of 27 enormous radio antennas spread across the earth. When used together, they act as one antenna, 22 miles across.) The Spitzer maps were models of what the radio continuum radiation around a particular galaxy would look like if there were no ram pressure.

When the team compared the model maps with the data they actually obtained, they found that regions along the outer edges of six of the galaxies were “highly deficient in the radio compared with [their] models.” The astronomers also detected infrared radiation “slightly beyond the observed radio disk.” These two galaxy characteristics, the team believes, “are the signatures of intracluster medium ram pressure.” Specifically, Murphy and his partners believe that the “strength” of the radio deficit seems to be a “good indicator of the strength of the current ram pressure.”

All in all, the evidence has settled a “long-standing debate” within the astronomy community: this team of astronomers has found clear evidence that galactic ram pressure exists, and affects the behavior of galaxies within clusters. Additionally, the team’s study has shown that the direction of the ram pressure on individual galaxies can now be measured.

And, says Murphy, “What is exciting is that the radio deficit regions appear to measure the current ram pressure’s strength, while other observations, though significant, merely demonstrate that the phenomenon exists.”

The astronomers also set up a control study, observing six galaxies not in the Virgo Cluster. Says Eric Murphy, “The control sample behavior clearly demonstrates that the radio deficiency morphology observed in Virgo galaxies is unique to cluster galaxies, and most naturally explained as a result of ram pressure interactions.”

Other authors of the paper are Jeff Kenney (from Yale University), George Helou (from Caltech), Aeree Chung (from University of Massachusetts at Amherst), and Justin Howell (at the Spitzer Science Center).

NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the Spitzer Space Telescope mission for NASA's Science Mission Directorate, Washington. Science operations are conducted at the Spitzer Science Center at the California Institute of Technology, also in Pasadena. Caltech manages JPL for NASA. For more information about Spitzer, visit http://www.spitzer.caltech.edu/spitzer and http://www.nasa.gov/spitzer.