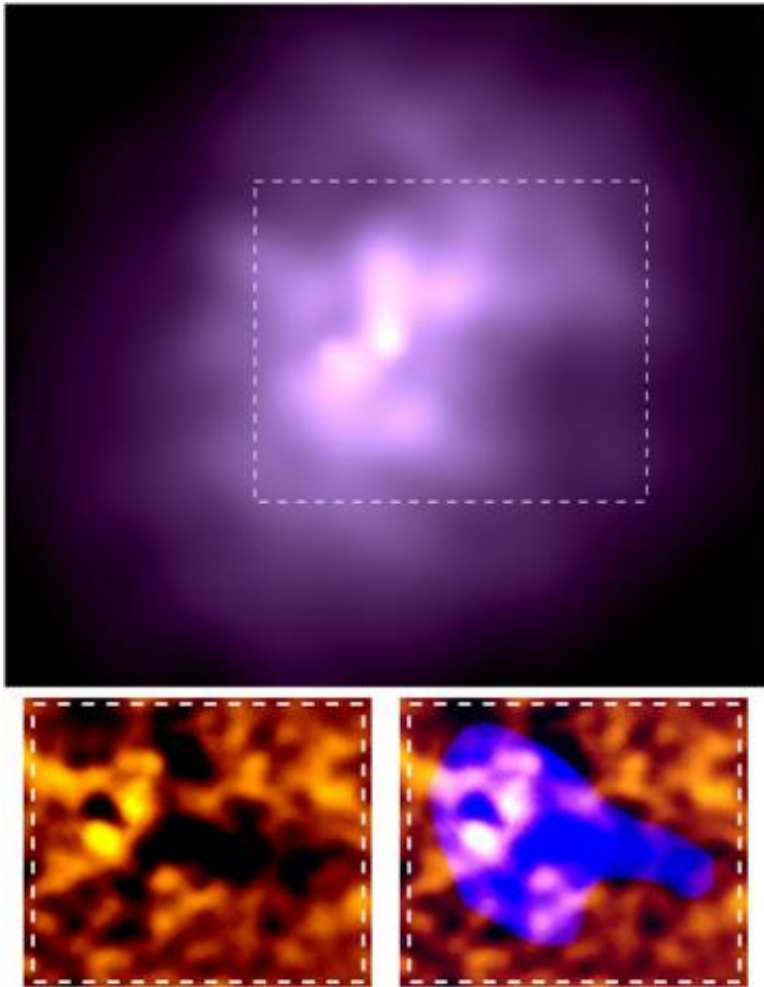


Cosmic battle creates Milky-Way sized tunnel

January 12 2006



The top image show the disturbed hot multi-million degree gas in Abell 2597 and the dashed rectangle shows the scale of the two lower images. Resembling the center of an apple invaded by worms, the X-ray emission in the lower left image shows a number of dark holes as well as a tunnel in the hot gas. The X-ray image has been processed to remove the smooth emission and highlight the central structure, similar to slicing through an apple to look at a cross-section of the core. The image on the right shows an overlay (in blue) of the low frequency

radio emission from the central supermassive black hole which has carved out the Milky-Way sized tunnel in the hot gas. This image was presented to the American Astronomical Society meeting in Washington, DC on January 12, 2006. PHOTO CREDIT: NRL/T. Clarke et al.

A team of astronomers is announcing today that they have discovered a giant Milky Way-sized tunnel filled with high energy particles in a distant galaxy cluster. These new findings are of special interest to astronomers as they may provide the missing evolutionary link necessary to understand the cycle of birth and death, as well as the environmental impact, of radio jets which result from ravenous supermassive black holes within giant galaxies.

Using the Chandra X-ray Observatory to study the multi-million degree gas in the galaxy cluster Abell 2597, the scientists discovered an unusual X-ray tunnel large enough to fit the entire Milky Way galaxy inside. The cluster, located at a distance of roughly one billion light years, contains a tunnel in the hot gas, which measures nearly 110 thousand light years by 36 thousand light years in size. The tunnel, which appears to originate near the core of the central giant galaxy in the cluster, may be more than 200 million years old.

A constant battle is being waged in the central regions of clusters of galaxies. The hot gas invades the core of the cluster and feeds the supermassive black hole that is lurking there. As the black hole eats more and more, it becomes active and nearby material is funneled into powerful jets of highly energetic particles (so-called radio jets) outward into the hot gas. These relativistic jets, containing particles moving at close to the speed of light, carve out bubbles while they expand, pushing aside the hot gas. Like a poorly planned invasion, these jets cut off the fuel supply to the central black hole, leading to a temporary starvation.

Without fuel to maintain the attack, the radio jets cease and the hot gas once again is able to invade the central region of the cluster and the battle begins again.

The new observations of a tunnel connecting from the central supermassive black hole to a distance nearly seven times the radio galaxy size in Abell 2597 suggest that the picture may be more complicated than previously thought. Past radio observations at a wavelength of roughly 4 cm, published in 1995 by Sarazin and collaborators, showed that this system was host to a small radio galaxy only 25 thousand light years across. Recently, Clarke and collaborators obtained new low frequency (90 cm wavelength) radio observations using the National Science Foundation's Very Large Array (VLA), which shed new light on the violent history of the central radio galaxy and its connection to the X-ray tunnel. "Low frequency radio observations are sensitive to the oldest energetic particles thus giving us a means to step even further back in time and look into the past lives of radio galaxies," explains Dr. Clarke. These new observations revealed that the X-ray tunnel is filled with old particles, invisible at shorter wavelengths, which likely originate from the past outbursts of the black hole.

"X-ray and radio observations show that the central supermassive black holes in clusters are at war with the surrounding X-ray gas" says Dr. Sarazin. "In Abell 2597, the small young radio source being inflated by the supermassive black hole at the center of this cluster is the start of a new battle. The tunnel is like a scar left from previous battles, showing that this war has been going on for billions of years. The fact that the tunnel connects back to the supermassive black hole suggests that the black hole is trying the breach the clusters defenses in the same area of the gas where it has been successful in the past."

Astronomers are far from understanding the complex interactions between radio jets and the hot gas in galaxy clusters. Observations of

new phenomena such as the tunnel in Abell 2597 are critical as they provide additional clues to how the battle is waged between the inward flow of the hot gas and the outward march of the radio jets. Further progress in the field will require sensitive observations at even longer wavelengths, but unfortunately the current suite of low frequency radio telescopes are already at their limits of sensitivity and resolution.

To address this shortcoming, astronomers at several institutions, collectively known as the Southwest Consortium, are contributing to an effort to build the world's largest and most sensitive low-frequency telescope, called the Long Wavelength Array (LWA). The LWA will operate at wavelengths between 15 and 3.75 meters (or 20 and 80 Megahertz) and has the potential to revolutionize future studies of radio galaxies and galaxy clusters.

Current plans call for the LWA to be sited near the VLA in New Mexico. "Ironically the LWA will operate at the same frequencies at which Carl Jansky first discovered extra-terrestrial radio emission, thus representing a return to the very roots of radio astronomy," notes Dr. Namir Kassim, a radio astronomer in NRL's Remote Sensing Division.

The report is being presented to the American Astronomical Society meeting in Washington, DC, by Dr. Tracy Clarke of Interferometrics, Inc. in Herndon, VA, and the Naval Research Laboratory (NRL) in Washington, DC; along with collaborators Dr. Craig Sarazin of the University of Virginia in Charlottesville, VA; Dr. Elizabeth Blanton of Boston University in Boston, MA; Dr. Namir Kassim, also of NRL; and Dr. Doris Neumann of CEA in Saclay, France.

Source: Naval Research Laboratory

Citation: Cosmic battle creates Milky-Way sized tunnel (2006, January 12) retrieved 9 April 2024 from <https://phys.org/news/2006-01-cosmic-milky-way-sized-tunnel.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.