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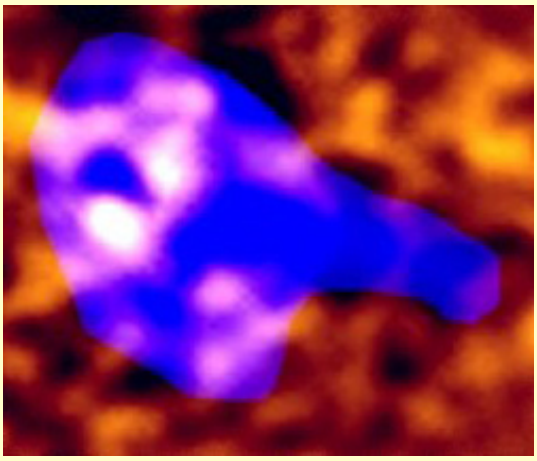
A Tunnel Through Space

By Nancy McGuire



False-color processed X-ray image (orange) with overlay of radio wave data (blue). The tunnel region appears dark blue. Photo Credit: Tracy Clarke, et al., NRL.

"A long time ago, in a galaxy far, far away..." Specifically, more than a billion years ago, in the center of the galaxy cluster Abell 2597, a tunnel formed that was large enough to house the entire Milky Way galaxy. The discovery of this tunnel was announced yesterday at a meeting of the American Astronomical Society in Washington, DC, by a team of investigators that included NRL researchers Dr. Tracy Clarke and Dr. Namir Kassim.

The immense oblong tunnel piercing the hot gas in the core of the galaxy cluster has a cross section of nearly 100,000 light years by 36,000 light years. (A light year is the distance that light travels over one year. The sun is about 8 light minutes from Earth.) Because Abell 2597 is about a billion light years from Earth, the "snapshots" that the research team obtained show the galaxy cluster as it appeared a billion years ago.

NRL, the Navy's corporate laboratory, was one of several agencies with a hand in this project. Hot gases in the interior of the galaxy cluster emit X-rays, which the research team observed using the Chandra X-ray Observatory, a satellite that has followed an elliptical orbit around the Earth since its launch in 1999. (The Smithsonian Astrophysical Observatory operates this observatory for NASA.) They also constructed images from low-frequency radio wave emissions using the National Science Foundation's Very Large Array (VLA), an assembly of radio-frequency receiver dishes in the New Mexico desert.

At the center of Abell 2597, a black hole consumes everything that comes within its reach. Just outside the limit of the black hole's reach, high-energy particles stream outward in "radio jets" that travel at nearly the speed of light. These jets sweep away the hot gases in their path, temporarily pushing them out of the reach of the black hole. With no gas streaming toward the black hole, the energy supply for the radio jets is cut off, and the jets stop. This allows the gas to flow back toward the black hole. The radio jets start up again, and the cycle begins anew.

Using the X-ray and radio observations (orange and blue in the top photo, respectively), the research team determined that the small, relatively young radio source at the center of Abell 2597 marks the start of a new cycle of radio jet emissions. (The radio source was about 200 million years old at the time the light started its journey toward Earth.)

Artist's conception of the Chandra X-ray Observatory. Photo Credit: CXC/NGST.

The large tunnel they observed (dark blue in the photo) is a remnant of previous cycles, which have probably been going on for billions of years, according to Dr. Craig Sarazin, a member of the research team from the University of Virginia at Charlottesville. Because the research team used low-frequency radio waves to construct their images, they saw previously unobserved particles that likely originated from past outbursts from the black hole.

The tunnel, which extends all the way back to the black hole, suggests that successive cycles of jets streaming away from the black hole follow the same path, in much the way that a river carves a channel.

Further studies will require detectors, not yet developed, for radio waves at even lower frequencies. The Southwest Consortium, a collaboration among astronomers at several institutions, is working to build the world's largest and most sensitive low-frequency telescope, the Long Wavelength Array. Current plans call for this array to be built near the VLA.

Clarke is also affiliated with Interferometrics, Inc. in Herndon, VA. Her collaborators in this project include Dr. Craig Sarazin of the University of Virginia in Charlottesville, VA; Dr. Elizabeth Blanton of Boston University in Boston, MA; and Dr. Doris Neumann of CEA in Saclay, France. Project support also came from NASA through the Chandra X-ray Observatory awards, and the National Radio Astronomy Observatory operates the Very Large Array radio telescope for the National Science Foundation under a cooperative agreement by Associated Universities, Inc.