Researchers explain the activity of black holes at the centre of galaxy clusters

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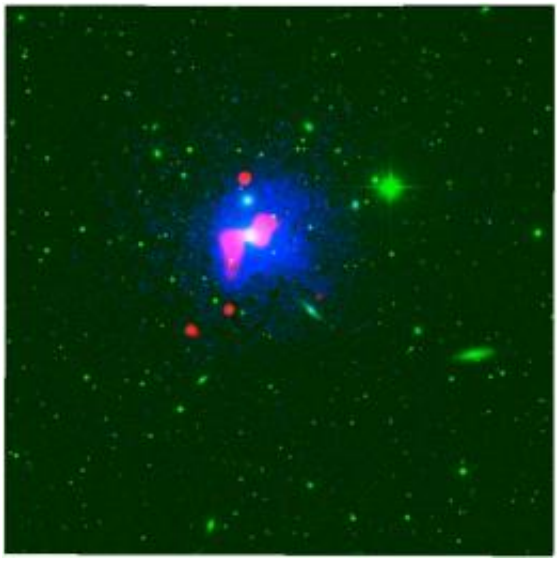

The galaxy cluster NGC507 as seen in three wavelengths. Blue shows the X-ray emission as observed by the Chandra satellite; red depicts the radio waves, which mark the activity of the supermassive black hole, as received by the Very Large Array in New Mexico; and green shows an optical image from the Digitized Sky Survey. The radio waves, and therefore indirectly the black hole's influence, cover a region that extends about 200,000 light years; i.e., they reach the outskirts of the central galaxy in this cluster. (Credits: R. Mittal, Bonn University, CXO, VLA)

(PhysOrg.com) -- Astronomers at the University of Bonn have clarified the connection between black holes at the centre of galaxy clusters and surrounding gas, which serves them as "food". The scientists have

produced a ground-breaking study of what could be called "cosmic feeding". It has now been published in the prestigious scientific journal *Astronomy and Astrophysics*.

A black hole is the term give by astronomers to a cosmic object whose gravitational force is so strong that it draws in everything in the immediate vicinity. Not even light can escape the pull. Scientists expect to find such phenomena at the centres of all major galaxies. Black holes vary considerably in size. Like boxers, they come in different "weight classes". Supermassive black holes can have a mass that is millions, or even billions, of times greater than our sun's.

"Supermassive black holes are not always 'active'," explains Dr. Thomas H. Reiprich. "In fact most black holes simply 'smoulder' away." Dr. Reiprich works at the Argelander Institute for Astronomy in Bonn, where he heads the Emmy Noether Research Group for "Studying the Nature of Dark Energy with Galaxy Clusters". He is particularly interested in understanding the black holes in the cores of galaxy clusters, which are the largest objects in the universe. By looking at the radiation in the vicinity of a black hole, astronomers are able to draw conclusions about their "food situation". The radiation derives from material that is being slowly absorbed by the black hole. This "food" is mainly ingested by the insatiable cosmic bodies in the form of hydrogen gas.

For black holes, gas is only "edible" if it is cooled down sufficiently - much like in real life! "The particles in hot gas move too quickly for them to come close enough to be pulled into a black hole," says Dr. Reiprich. His colleague Dr. Rupal Mittal, the study's principal author, adds, "For that to happen, the gaseous mixture must cool down. Just how long the cooling process lasts can vary. A billion years is very a short period by cosmic standards." The black hole at the centre of a galaxy cluster in which the gas cools "quickly" enough will receive "edible" gas

in abundance and be correspondingly active. The centres of galaxy clusters in which these processes take considerably longer are, in turn, far less lively.

Fast-cooling gas as fuel

The idea that all central black holes in galaxy clusters are active if there is sufficient gas available was already postulated by scientists. But the current work by the Bonn research group furnishes the evidence. "Earlier research had identified a high proportion of such galaxy clusters, but we have now been able to demonstrate that it's not just a 70 per cent incidence but applies to all cases," Reiprich sums up. "All galaxy clusters that cool down rapidly, and thus have an abundance of gas available in their interior, reinvigorate supermassive black holes - like a fresh log on a dying wood-fire. In other words, the black holes will really get going if their wide environment is right."

As part of their study, the researchers in Bonn combined the measurement of radio waves with X-ray images of more than sixty galaxy clusters. Thanks to improved data, they were able to examine these phenomena more closely than previous investigations managed to do. Using the X-ray observations they determined which galaxy clusters contain, in their cores, gas that can serve as food for black holes. And, by means of radio data, the Bonn-based scientists analysed the activity of supermassive black holes.

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