Driving massive galaxy outflows with supermassive blackholes

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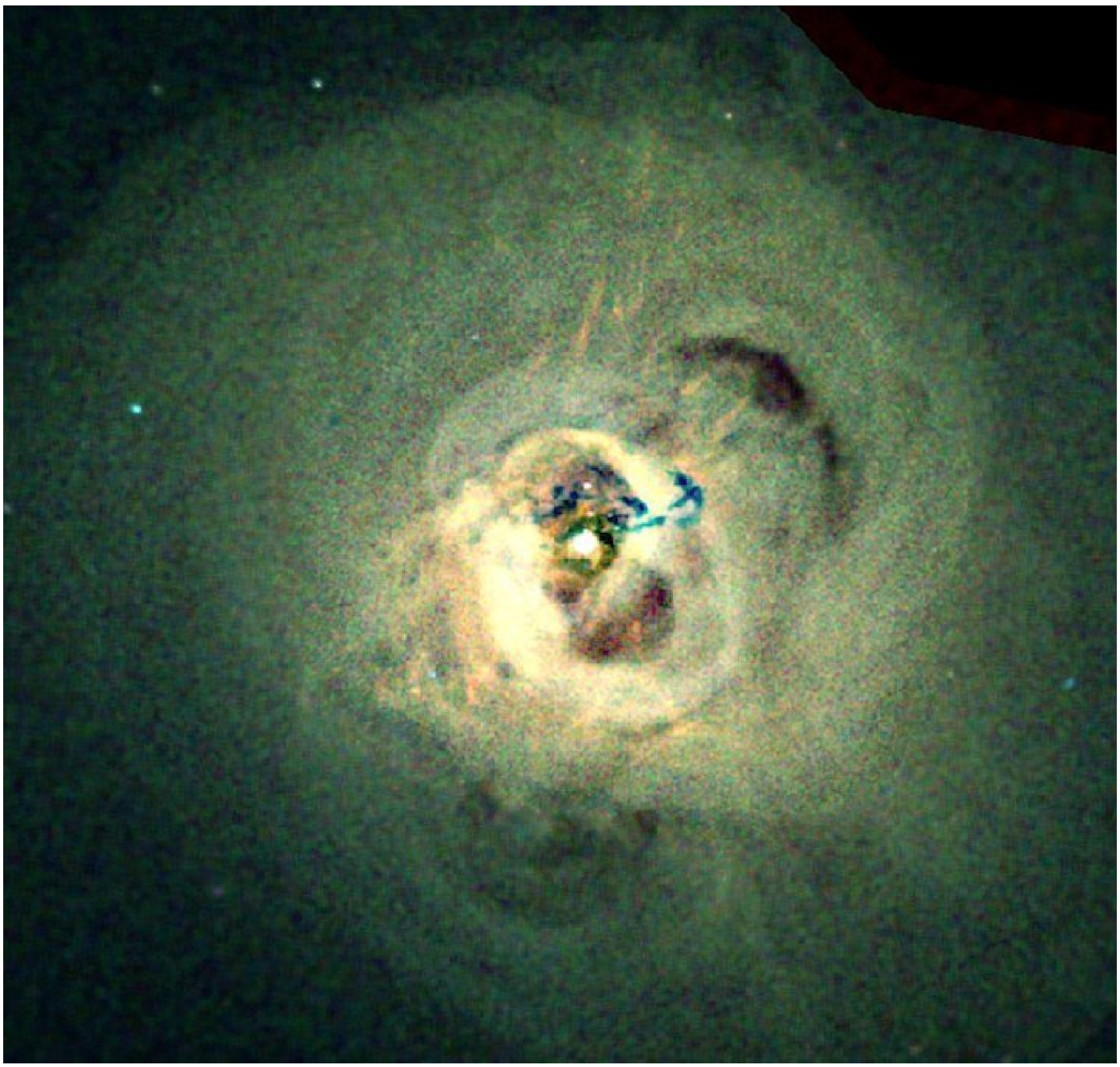

A Chandra X-ray Observatory image of the center of the Perseus cluster of galaxies. Astronomers used the ALMA millimeter facility to study AGN quenching mechanisms and the molecular filament structures in twelve galaxy clusters. Credit: NASA/CXC/IoA/A.Fabian et al.

Active galactic nuclei (AGN) are supermassive black holes at the centers of galaxies that are accreting material onto their hot circumnuclear disks, releasing the energy in bursts of radiation or as particle jets moving at close to the speed of light. These energetic outbursts in turn drive outflows of ionized, neutral, and molecular gas that can extend over thousands of light-years and move at speeds of hundreds of kilometers per second. The gas flows can be launched directly from the hot accretion disc, though radiation pressure on the dust that is mixed in with the gas, by hot thermal winds, or other mechanisms that generate hot bubbles of gas. By driving the gas out of the galaxy, an active nucleus restricts the fuel available for further star formation and slows down the galaxy's growth. The mechanism is also self-limiting, since it ultimately suppresses gas accreting onto the black hole. Astronomers tracking the rate of star formation across cosmic time believe this process, called quenching, is responsible for the dramatic decline in star formation since the peak of star-formation activity about ten billion years ago.

CfA astronomer Paul Nulsen and his colleagues used new and archival data from the ALMA millimeter facility to study molecular gas outflows in twelve massive galaxies at the centers of galaxy clusters. The hot gas surrounding the galaxies in these massive clusters should cool, fall back onto the galaxies, and produce more new stars, continuing the feedback cycle. The high spatial resolution of the ALMA images, taken in the emission line of carbon monoxide gas, enabled the scientist to investigate the processes in detail, in particular the filamentary structures that characterize most of the gas in these central cluster galaxies. They find that giant molecular filaments and clouds apparently form as the hot bubbles of escaping gas begin to cool, and that these outflows will eventually stall and recirculate in the galaxy. They also identify a trend between the mass of the molecular gas directly around the central AGN and the power of the jet.

More information: H R Russell et al. Driving massive molecular gas flows in central cluster galaxies with AGN feedback, *Monthly Notices of the Royal Astronomical Society* (2019). DOI: 10.1093/mnras/stz2719

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