Black holes are firing beams of particles, changing targets over time

May 27 2024, by Andy Tomaswick

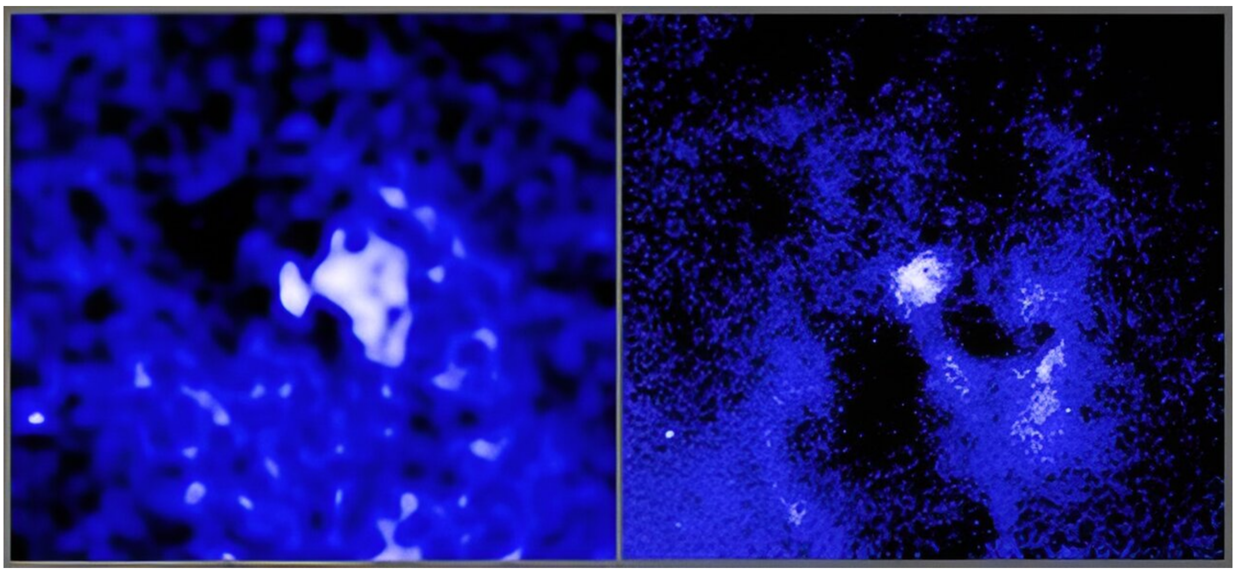

Image from Chandra's X-Ray and VLBA's radio data set of a black hole's jets with "cavities" surrounding it. Credit: X-ray: NASA/CXC/Univ. of Bologna/F. Ubertosi; Inset Radio: NSF/NRAO/VLBA; Image Processing: NASA/CXC/SAO/N. Wolk

Black holes seem to provide endless fascination to astronomers. This is at least partly due to the extreme physics that takes place in and around them, but sometimes, it might harken back to cultural touchpoints that made them interested in astronomy in the first place.

That seems to be the case for the authors of a new paper published in *The Astrophysical Journal* on the movement of jets coming out of black holes. Dubbing them "Death Star" black holes, researchers used data from the Very Long Baseline Array (VLBA) and the Chandra X-ray Observatory to look at where these black holes fired jets of superheated particles. And over time, they found they did something the fictional Death Star could also do—move.

The black holes at the center of the study were supermassive ones at the centers of galaxies. Importantly, they were all surrounded by hot gases that were visible to Chandra's X-ray sensors. The jets themselves were clearly visible in the data, but there was other important information hiding in it—namely, pockets free from gas, which had been pushed away by the jets.

Each black hole has particle jets in two opposing directions. As those jets push away gas and dust, they open up a pocket in space surrounding the black hole. These are visible in the X-ray data due to a lack of signal from those regions. The researchers hypothesized that the jets should align with the pockets of free space they create.

However, they found that, in at least six of the 16 black holes they were studying, the beams had completely changed direction such that the pockets of missing gas no longer aligned with the jets currently emitted from the black hole. In some cases, these changes added up to a 90-degree shift in the direction the jets were facing.

What's even more impressive, they seemed to move on a relatively small time scale, with estimates ranging from 1 to 10 million years. That is a blink of an eye for a black hole over 10 billion years old.

So why is this important? Cosmologists theorize that these disruptive jets put an upper limit on the number of stars that form in the host galaxy of the black holes. They don't let the gas and dust surrounding them cool down enough to start to form stars and rocky planets.

So, while it isn't clear if the jets of particles themselves are roasting any formed planets like the actual Death Star, it is clear that moving the jets around would cause an even more massive disruption in the star-forming process. In theory, this would mean that galaxies containing these moving jets would have fewer stars, but that is a study for another paper.

Understanding exactly why this is happening might also need to be researched in another paper, but the authors have a few theories. Matter orbiting around the black hole and falling into it could cause the black hole to rotate, causing the jets it emits to move with it.

Another explanation is that the gas is moving around the galaxy without being impacted by the beams. In essence, the "cavities" of no gas in a galaxy are remnants of other cosmological forces and have nothing to do with the black hole beams.

However, the authors don't think this is likely because the galaxy mergers that could be one source of causing the "sloshing" happened in the galaxies that had the moving beams and those that didn't. One would expect the cavities to be present in both types if they were caused by galaxies merging rather than moving jets of particles.

As always, there is more science to do. Thanks to the wonderful world of video streaming, a whole generation of new scientists inspired by the same Death Star could do it.

More information: Francesco Ubertosi et al, Jet Reorientation in Central Galaxies of Clusters and Groups: Insights from VLBA and

Chandra Data, *The Astrophysical Journal* (2024). DOI: 10.3847/1538-4357/ad11d8

Provided by Universe Today