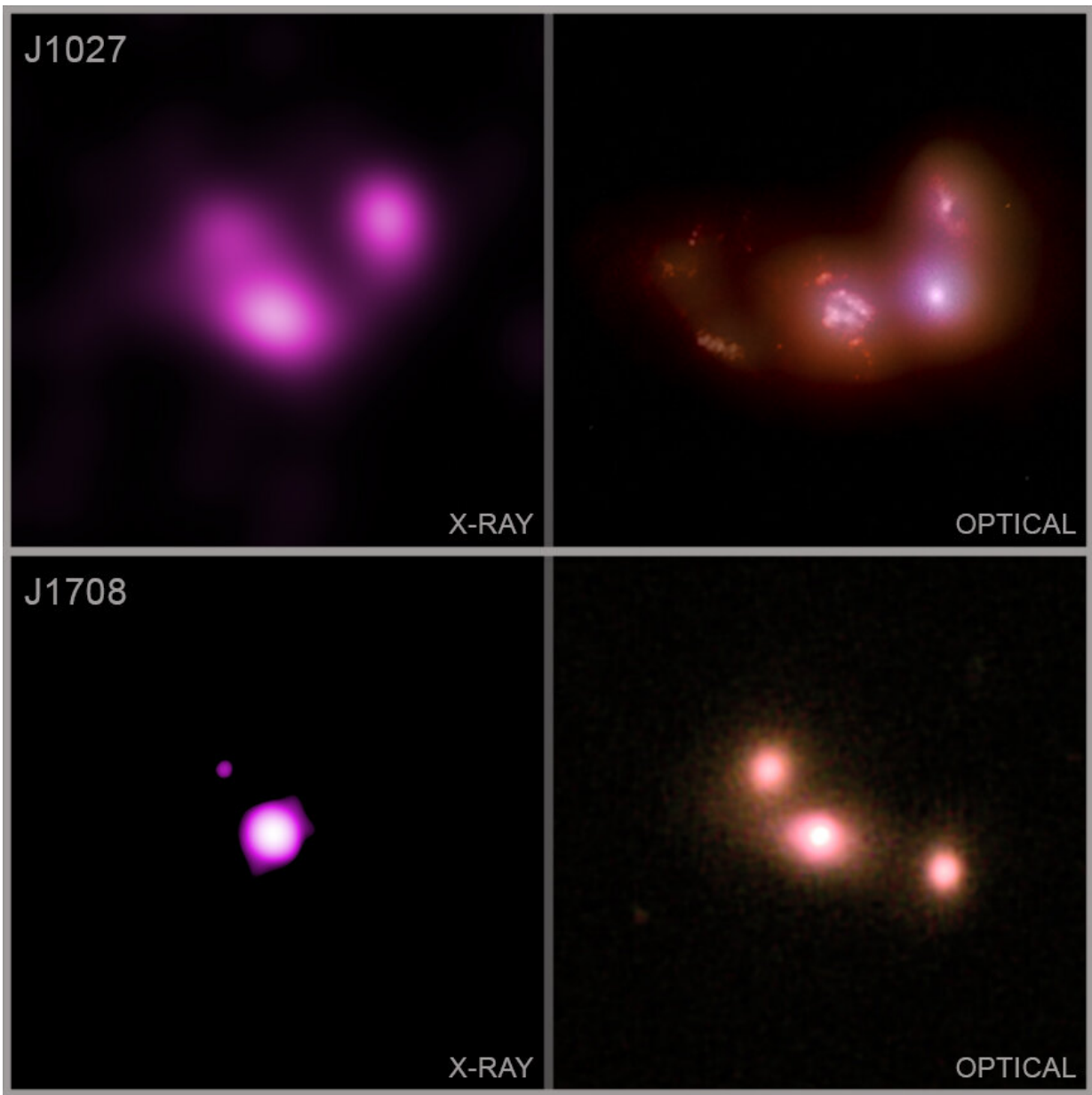


# Galaxies hit single, doubles, and triple (growing black holes)

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This pair of objects comes from a study of seven triple galaxy mergers. By using Chandra and other telescopes, astronomers determined what happened to the supermassive black holes at the centers of the galaxies after the collision of three galaxies. The results show a range of outcomes: a single growing supermassive black hole, four doubles, a triple, and one system where no black holes are rapidly pulling in matter. Two of the doubles are shown here in X-rays (Chandra) and optical light (SDSS and Hubble). This information tells astronomers more about how galaxies and the giant black holes in their centers grow over cosmic time. Credit: X-ray: NASA/CXC/Univ. of Michigan/A. Foord et al.; Optical: SDSS & NASA/STScI

When three galaxies collide, what happens to the huge black holes at the centers of each? A new study using NASA's Chandra X-ray Observatory and several other telescopes reveals new information about how many black holes are furiously growing after these galactic smash ups.

Astronomers want to learn more about galactic collisions because the subsequent mergers are a key way that [galaxies](#) and the giant [black holes](#) in their cores grow over cosmic time.

"There have been many studies of what happens to supermassive black holes when two galaxies merge," said Adi Foord of Stanford University, who led the study. "Ours is one of the first to systematically look at what happens to black holes when three galaxies come together."

She and her colleagues identified triple galaxy merger systems by cross-matching the archives—containing data that is now publicly available—of NASA's WISE mission and the Sloan Digital Sky Survey (SDSS) to the Chandra archive. Using this method they found seven triple galaxy mergers located between 370 million and one billion light years from Earth.

Using specialized software Foord developed for her Ph.D. at the University of Michigan in Ann Arbor, the team went through Chandra data targeting these systems to detect X-ray sources marking the location of growing supermassive black holes. As material falls toward a black hole, it gets heated to millions of degrees and produces X-rays.

Chandra, with its sharp X-ray vision, is ideal for detecting growing supermassive black holes in mergers. The associated X-ray sources are challenging to detect because they are usually close together in images and are often faint. Foord's software was developed specifically to find such sources. Data from other telescopes was then used to rule out other possible origins of the X-ray emission unrelated to supermassive black holes.

The results from Foord and the team show that out of seven triple galaxy mergers there is one with a single growing supermassive black hole, four with double growing supermassive black holes, and one that is a triple. The final triple merger they studied seems to have struck out with no X-ray emission detected from the supermassive black holes. In the systems with multiple black holes, the separations between them range between about 10,000 and 30,000 [light years](#).

"Why do we care about the hitting percentage of these black holes?" said co-author Jessie Runnoe of Vanderbilt University in Nashville, Tenn. "Because these statistics can tell us more about how black holes and the galaxies they inhabit grow."

Once they found evidence for bright X-ray sources as candidates for growing supermassive black holes in the Chandra data, the researchers incorporated archival data from other telescopes. Like a second umpire conferring about the original call, these data backed up the idea that multiple black holes were present in the merged galaxies.

To make these calls the authors studied infrared data from the WISE mission, the Infrared Astronomical Satellite, and the Two Micron All Sky Telescope to see how quickly stars are forming in the different galaxies in their survey. This allowed them to estimate how many of the detected X-rays are likely to come from X-ray emitting systems containing massive stars, rather than a growing supermassive black hole. Because such star systems are young they are more common when stars are forming more quickly. Foord and her colleagues used this technique to conclude that one of the X-ray sources they found is likely from a collection of X-ray emitting star systems.

The Chandra and WISE data show that the system with growing supermassive black holes has the largest amount of dust and gas. This matches theoretical computer simulations of mergers that suggest higher levels of gas near black holes are more likely to trigger rapid growth of the black holes.

Studies of triple mergers can help scientists understand whether pairs of supermassive black holes can approach so close to each other that they make ripples in spacetime called gravitational waves. The energy lost by these waves will inevitably cause the black holes to merge.

The Laser Interferometer Gravitational Wave Observatory (LIGO) and Virgo array in Europe have shown astronomers that stellar-mass black holes create gravitational waves and merge, but it is not known if supermassive black holes do.

"There is a "nightmare scenario" where supermassive black holes cannot lose enough energy to come close together and make [gravitational waves](#)" said co-author Michael Koss of Eureka Scientific in Oakland, California. "If this is the case then projects like LISA and pulsar timing arrays won't have any supermassive black hole mergers to detect".

However, gravitational interactions from a third [supermassive black hole](#) may prevent this stalling process. Studies of supermassive black holes in systems where three galaxies are merging are therefore important for understanding whether the nightmare scenario might apply.

The system with three growing supermassive black holes had previously been reported by Ryan Pfeifle of George Mason University in Fairfax, Virginia in a Chandra press release and an October 2019 paper in *The Astrophysical Journal*, and a team led by Xin Lui of the University of Illinois at Urbana-Champaign in a December 2019 paper in *The Astrophysical Journal*. This latest result helps put that discovery into context of other triple mergers of galaxies.

Foord presented the new study at the 237th meeting of the American Astronomical Society, which is being held virtually from January 11-15, 2021. Two papers describing this work have recently been accepted for publication in *The Astrophysical Journal*..

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