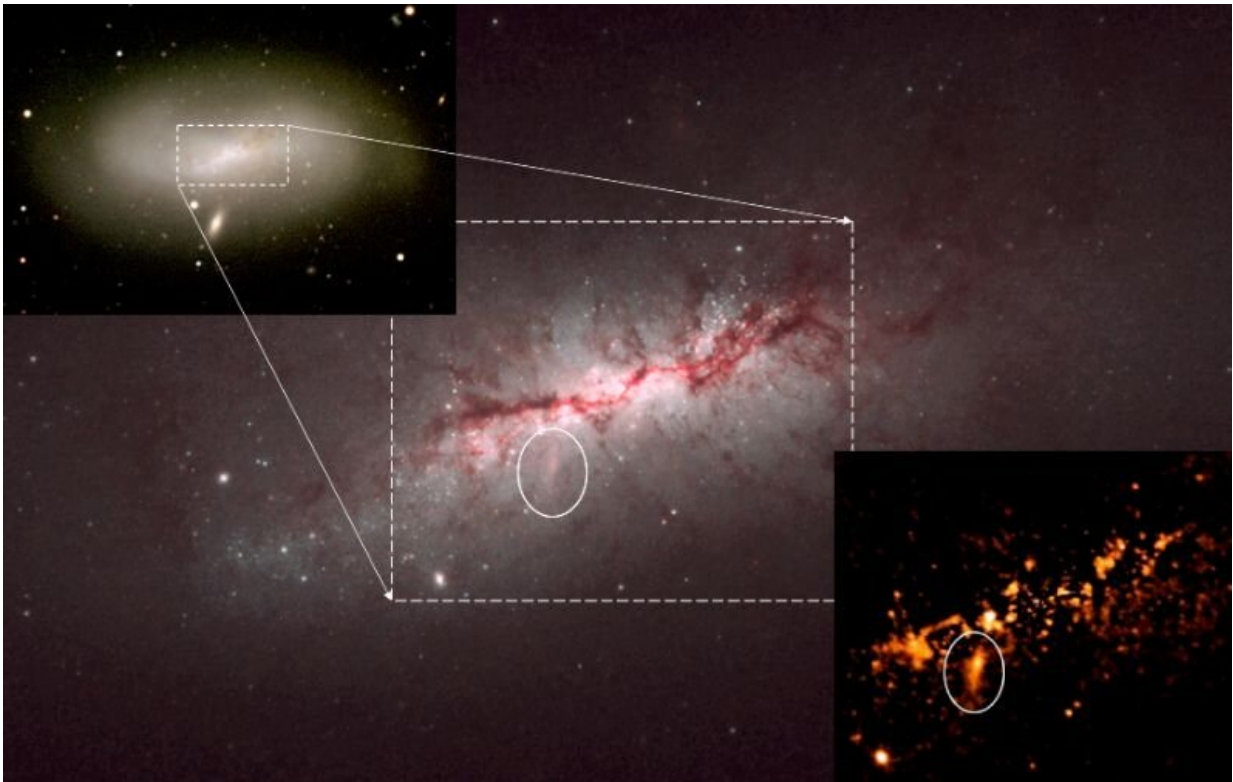


# Galaxy evolution: A cosmic romance written in the stars

January 19 2022

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Researchers made the discovery in the inner region of a spiral galaxy (called galaxy NGC 4424), similar to our own – the Milky Way. Credit: Swinburne University of Technology

An international team of astronomers has taken a step forward in understanding the evolution of galaxies, and in so doing, told a story

written in the heavens.

It has long been a mystery how some spiral galaxies obtained their central black hole. By combining visible and X-ray observations, astronomers have now discovered traces of what was probably once a small sphere-shaped galaxy, seen falling into a [spiral galaxy](#) and delivering what is thought to be the right-sized black hole.

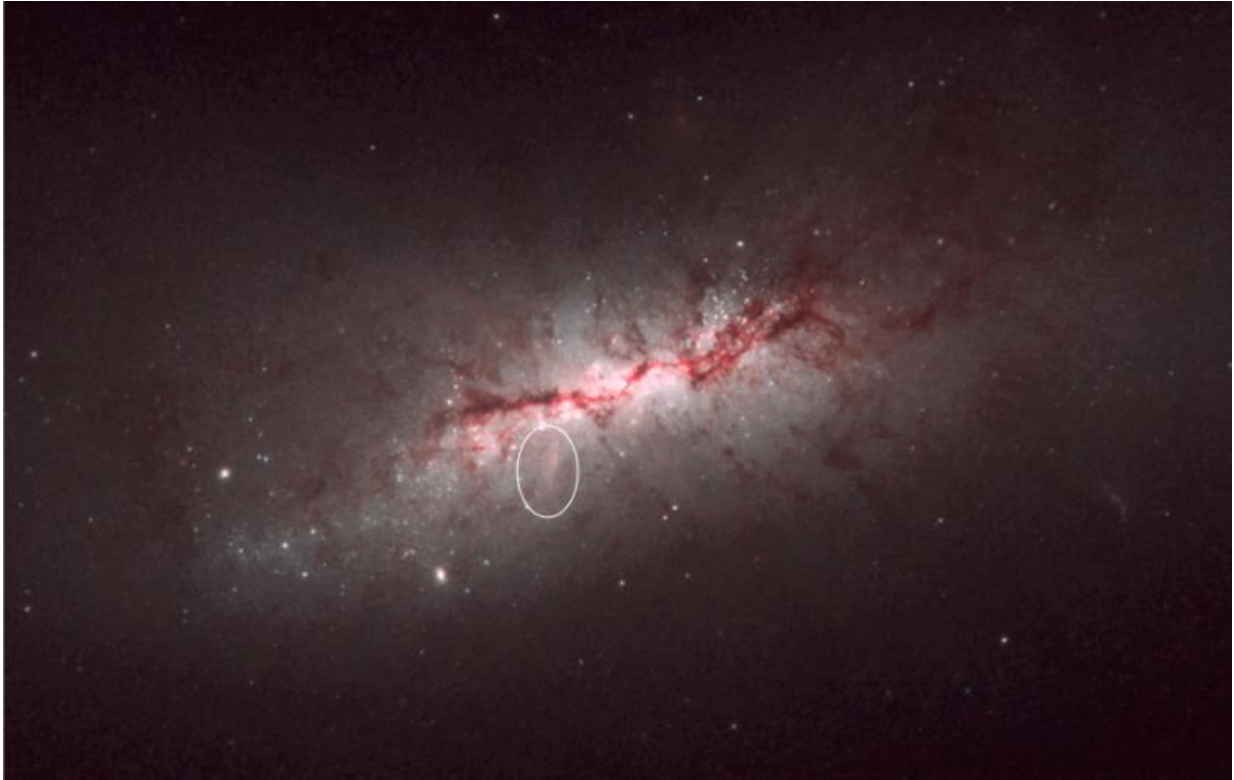
The facts make for a cosmic romance, a similarity not lost on lead author of this new research, Professor Alister Graham, from Swinburne's Center for Astrophysics and Supercomputing and teaching into Swinburne Astronomy Online.

Galaxies can have mutual (gravitational) attraction for each other. The body of a smaller galaxy may fade over time, but its heart remains intact as it falls into and partners with a larger galaxy.

In this case, the heart is a million-strong cluster of stars, seen with the Hubble Space Telescope near the center of the spiral galaxy NGC 4424.

NGC 4424 was already known to display signs of activity from a past merger event. Professor Graham says, "The galaxy's bar-like structure is excited and buckled. There was also a star-forming event less than 500 million years ago. One can think of this as a star party of sorts, associated with the announcement of the upcoming galaxy wedding."

However, he is quick to add that, "This appears to be an important discovery for understanding the coevolution of black holes and galaxies."



Zoomed-in images of galaxy NGC 4424 gave them a better view of the star cluster. . [Credit:](#) NASA/ESA, Or Graur (University of Portsmouth), Adam Riess (Johns Hopkins University), Lisa Frattare (Space Telescope Science Institute)

### **A massive discovery**

This is the first infalling galaxy found to have a massive black hole. The discovery contributes to our understanding of how black holes come to be inside spiral galaxies.

The astronomers have informally named the star cluster "Nikhuli." They turned to the Sumi tribe in the Indian State of Nagaland for the word, used for a festive period where the descendants of head-hunters celebrate and wish for a rich harvest and gathering. It seemed

appropriate to the astronomers, who refer to space as 'the field' and whose discovery focuses on how a larger galaxy has harvested a smaller galaxy.

## **What the X-ray images show us**

Professor Roberto Soria, a co-author at the Chinese Academy of Sciences, obtained a Chandra X-ray Observatory image showing a high-energy X-ray source emanating from the stretched-out star cluster seen in the Hubble image.

"We are likely seeing activity from around a black hole within what was the centrally-located star cluster of the infalling galaxy," says Soria.

Although 50 million light-years away, each square meter of Earth is bathed in an X-ray from this active black hole roughly every 80 seconds. The X-ray hotspot is just 1300 light-years from the center of NGC 4424, a galaxy some sixty thousand light-years across.

The main body of the smaller galaxy—which once housed the resilient star cluster—is now contributing to an inner 'bulge' of stars above and below the spiral galaxy's disc, which contains the bar and spiral pattern.



Astronomers have circled the star cluster informally named Nikhuli. Credit: NASA/ESA, Bogdan Ciambur (Paris Observatory), Alister Graham (Swinburne University of Technology)

## **Expanding our knowledge of the universe**

The team's best estimate for the mass of the black hole is seventy thousand times the mass of our Sun. This mass makes it a candidate for the largely missing population of "intermediate-mass" black holes with masses greater than stars and smaller than the supermassive black holes known to reside at the centers of giant galaxies, like M87—which is often remembered as the famous first-ever image of a black hole, taken by the Event Horizon Telescope.

"This in itself is exciting," says Graham. "Moreover, this mass is on par with that expected at the center of NGC 4424."

"We may be witnessing a supply mechanism for black holes into spiral galaxies," says Dr. Ben Davis, a co-author at the New York University's campus in Abu Dhabi.

"Furthermore, potential collisions with other black holes make this an ideal setting for the emission of long-wavelength gravitational waves rippling across space," says Davis.

## The next step

Professor Graham, Professor Soria and Dr. Davis are determined to find more infalling galaxies containing black holes in their drive to answer how black holes come to be within spiral [galaxies](#).

Professor Graham and Dr. Ben Davis are also members of the LISA Consortium, whose Laser Interferometer Space Antenna, aka LISA, and the Chinese TianQin (天琴) space missions are working towards discovering events involving the collision of big [black holes](#).

Perhaps their future discoveries can be the romantic sequel, akin to something Sheldon from "The Big Bang Theory" might have penned.

**More information:** Alister W. Graham et al, Potential Black Hole Seeding of the Spiral Galaxy NGC 4424 via an Infalling Star Cluster, *The Astrophysical Journal* (2021). [DOI: 10.3847/1538-4357/ac235b](https://doi.org/10.3847/1538-4357/ac235b)

Provided by Swinburne University of Technology

Citation: Galaxy evolution: A cosmic romance written in the stars (2022, January 19) retrieved 19 April 2024 from

<https://phys.org/news/2022-01-galaxy-evolution-cosmic-romance-written.html>

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