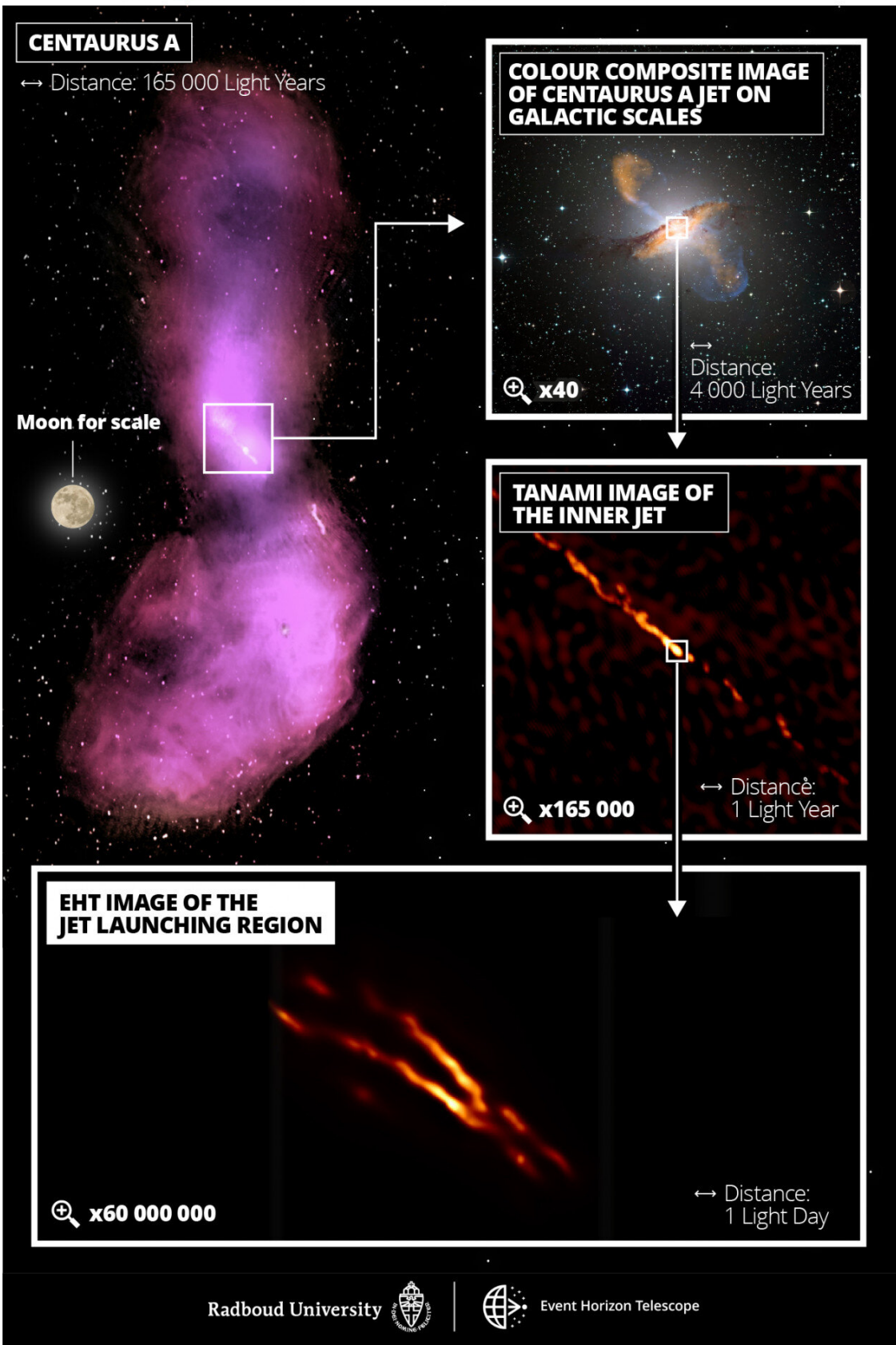


EHT pinpoints dark heart of the nearest radio galaxy

July 19 2021

Zooming into the heart of Centaurus A





CENTAURUS A
↔ Distance: 165 000 Light Years

Moon for scale

COLOUR COMPOSITE IMAGE OF CENTAURUS A JET ON GALACTIC SCALES
↔ Distance: 4 000 Light Years
x40

TANAMI IMAGE OF THE INNER JET
↔ Distance: 1 Light Year
x165 000

EHT IMAGE OF THE JET LAUNCHING REGION
↔ Distance: 1 Light Day
x60 000 000

Radoud University  |  Event Horizon Telescope

Distance scales uncovered in the Centaurus A jet. The top left image shows how the jet disperses into gas clouds that emit radio waves, captured by the ATCA and Parkes observatories. The top right panel displays a color composite image, with a 40x zoom compared to the first panel to match the size of the galaxy itself. Submillimeter emission from the jet and dust in the galaxy measured by the LABOCA/APEX instrument is shown in orange. X-ray emission from the jet measured by the Chandra spacecraft is shown in blue. Visible white light from the stars in the galaxy has been captured by the MPG/ESO 2.2-metre telescope. The next panel below shows a 165 000x zoom image of the inner radio jet obtained with the TANAMI telescopes. The bottom panel depicts the new highest resolution image of the jet launching region obtained with the EHT at millimeter wavelengths with a 60 000 000x zoom in telescope resolution. Indicated scale bars are shown in light years and light days. One light year is equal to the distance that light travels within one year: about nine trillion kilometers. In comparison, the distance to the nearest-known star from our Sun is approximately four light years. One light day is equal to the distance that light travels within one day: about six times the distance between the Sun and Neptune. Credit: Radboud University; CSIRO/ATNF/I. Feain et al., R. Morganti et al., N. Junkes et al.; ESO/WFI; MPIfR/ESO/APEX/A. Weiß et al.; NASA/CXC/CfA/R. Kraft et al.; TANAMI/C. Müller et al.; EHT/M. Janßen et al.

An international team anchored by the Event Horizon Telescope (EHT) Collaboration, which is known for capturing the first image of a black hole in the galaxy Messier 87, has now imaged the heart of the nearest radio galaxy Centaurus A in unprecedented detail. The astronomers pinpoint the location of the central supermassive black hole and reveal how a gigantic jet is being born. Most remarkably, only the outer edges of the jets seem to emit radiation, which challenges our theoretical models of jets. This work, led by Michael Janssen from the Max Planck Institute for Radio Astronomy in Bonn and Radboud University

Nijmegen is published in *Nature Astronomy* on 19 July.

At radio wavelengths, Centaurus A emerges as one of the largest and brightest objects in the night sky. After it was identified as one of the first known extragalactic radio sources in 1949, Centaurus A has been studied extensively across the entire electromagnetic spectrum by a variety of radio, infrared, optical, X-ray, and gamma-ray observatories. At the center of Centaurus A lies a black hole with the mass of 55 million suns, which is right between the masses of the Messier 87 black hole (six and a half billion suns) and Sgr A* in the center of our own galaxy (about four million suns).

In a new paper in *Nature Astronomy*, data from the 2017 EHT observations have been analyzed to image Centaurus A in unprecedented detail. "This allows us for the first time to see and study an extragalactic radio jet on scales smaller than the distance light travels in one day. We see up close and personally how a monstrously gigantic jet launched by a [supermassive black hole](#) is being born," says astronomer Michael Janssen.

Compared to all previous high-resolution observations, the jet launched in Centaurus A is imaged at a tenfold higher frequency and 16 times sharper resolution. With the resolving power of the EHT, astronomers can now link the vast scales of the source, which are as big as 16 times the angular diameter of the moon on the sky, to their origin near the black hole in a region of merely the width of an apple on the moon when projected on the sky. That is a magnification factor of one billion.

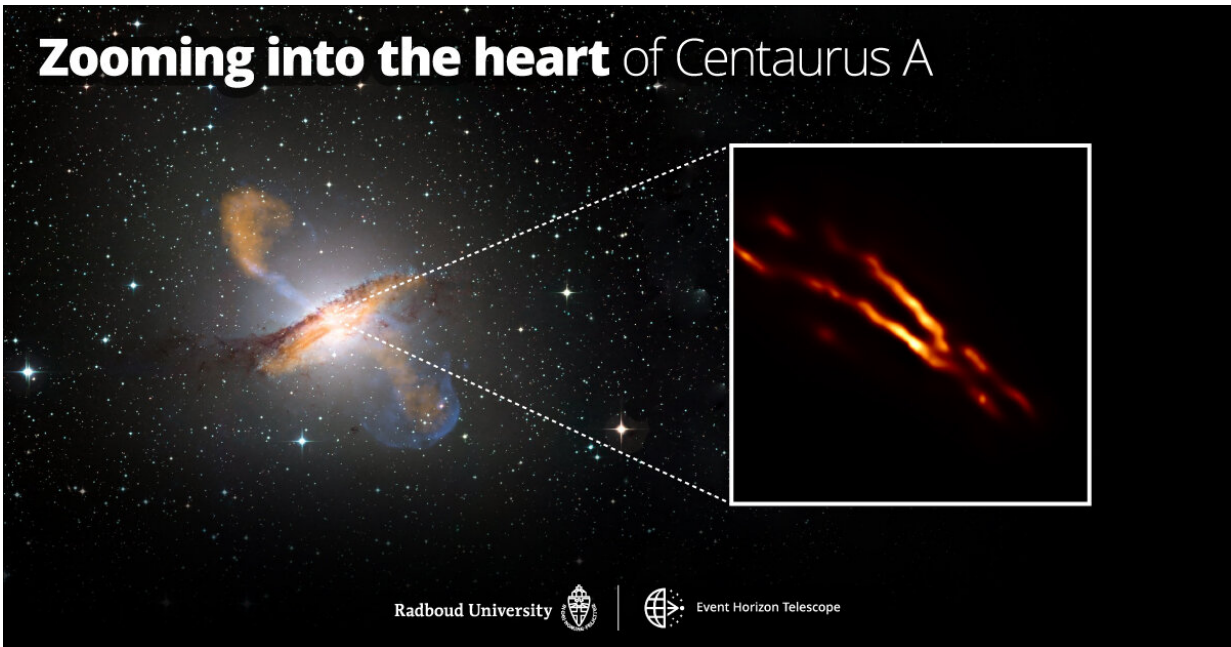
Understanding jets

Supermassive [black holes](#) residing in the center of galaxies like Centaurus A are feeding off gas and dust that is attracted by their enormous gravitational pull. This process releases massive amounts of

energy and the galaxy is said to become "active." Most matter lying close to the edge of the black hole falls in. However, some of the surrounding particles escape moments before capture and are blown far out into space: Jets—one of the most mysterious and energetic features of galaxies—are born.

Astronomers have relied on different models of how matter behaves near the black hole to better understand this process. But they still do not know exactly how jets are launched from its central region and how they can extend over scales that are larger than their host galaxies without dispersing. The EHT aims to resolve this mystery.

The new image shows that the jet launched by Centaurus A is brighter at the edges compared to the center. This phenomenon is known from other jets, but has never been seen so pronouncedly before. "We found it challenging to explain with the same models we used for M87. Something different must be happening, like helical magnetic fields, which gives us new clues about how they may 'squeeze' the jets," says Sera Markoff, vice-chair, EHT Science Council and professor for theoretical high-energy astrophysics at University of Amsterdam.



Right: highest resolution image of Centaurus A obtained with the Event Horizon Telescope. Left: color composite image of the entire galaxy. Credit: Radboud University; ESO/WFI; MPIfR/ESO/APEX/A. Weiß et al.; NASA/CXC/CfA/R. Kraft et al.; EHT/M. Janßen et al.

Future observations

With the new EHT observations of the Centaurus A jet, the likely location of the black hole has been identified at the launching point of the jets. Based on this location, the researchers predict that future observations at an even shorter wavelength and higher resolution would be able to photograph the central black hole of Centaurus A. This will require the use of space-based satellite observatories.

"These data are from the same observing campaign that delivered the famous image of the black hole in M87. The new results show that the EHT provides a treasure trove of data on the rich variety of black holes

and there is still more to come," says Heino Falcke, EHT board member and professor for Astrophysics at Radboud University.

Background information

To observe the Centaurus A galaxy with this unprecedentedly sharp resolution at a wavelength of 1.3 mm, the EHT collaboration used very long baseline interferometry (VLBI), the same technique with which the famous image of the black hole in M87 was made. An alliance of eight telescopes around the world joined together to create the virtual Earth-sized Event Horizon Telescope. The EHT collaboration involves more than 300 researchers from Africa, Asia, Europe, North and South America.

TANAMI (Tracking Active Galactic Nuclei with Austral Milliarcsecond Interferometry) is a multiwavelength program to monitor relativistic jets in active galactic nuclei of the Southern Sky. This program has been monitoring Centaurus A with VLBI at centimeter-wavelengths since the mid 2000s. The [TANAMI array](#) consists of nine radio telescopes located on four continents observing at wavelengths of 4 cm and 1.3 cm.

More information: Event Horizon Telescope observations of the jet launching and collimation zone in Centaurus A. By M. Janssen, H. Falcke, M. Kadler, E. Ros, M. Wielgus et al. (EHT Collaboration), *Nature Astronomy*, 19 July 2021. [DOI: 10.1038/s41550-021-01417-w](https://doi.org/10.1038/s41550-021-01417-w) , www.nature.com/articles/s41550-021-01417-w

Provided by Netherlands Research School for Astronomy

Citation: EHT pinpoints dark heart of the nearest radio galaxy (2021, July 19) retrieved 2 May 2024 from <https://phys.org/news/2021-07-eh-t-dark-heart-nearest-radio.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.