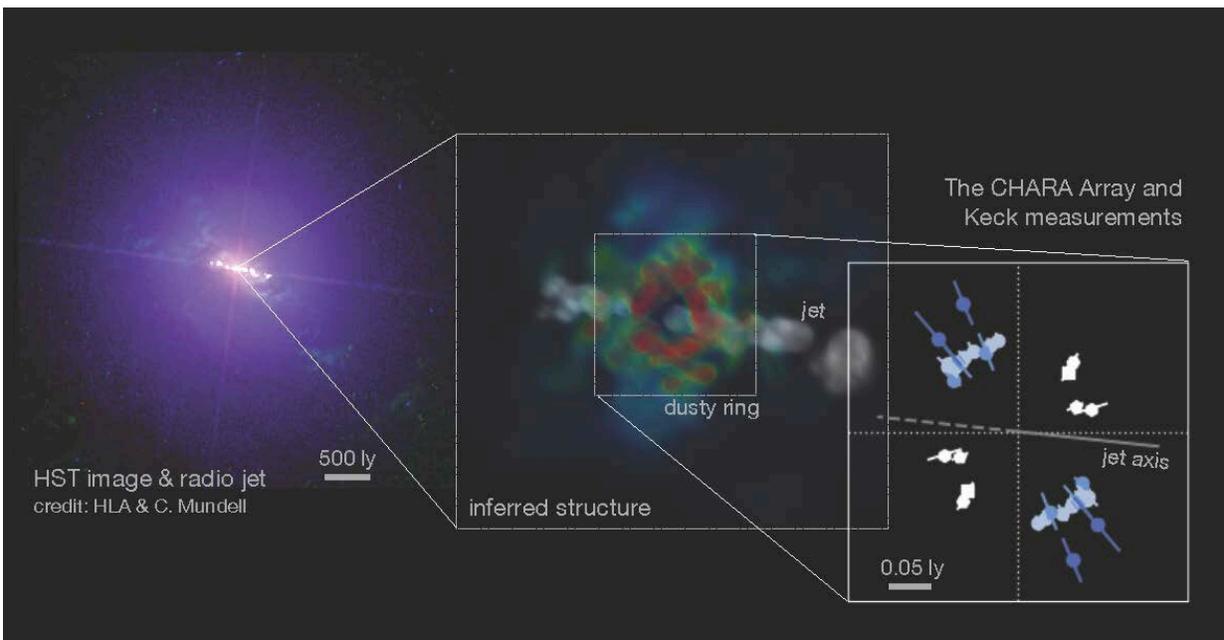


CHARA Array detects elusive, dusty inner region of distant galaxy

November 18 2022



A team of international scientists working at Georgia State's CHARA Array has captured a long-sought-after view of the dusty inner region in a galaxy called NGC 415. Credit: Georgia State University/CHARA ARRAY

An international team of scientists has achieved the milestone of directly observing the long-sought, innermost dusty ring around a supermassive black hole, at a right angle to its emerging jet. Such a structure was thought to exist in the nucleus of galaxies but had been difficult to observe directly because intervening material obscured our line of sight.

Now the inner disk is detected using the highest spatial resolution in the [infrared wavelengths](#) ever done for an extragalactic object. The new discovery was just published in *The Astrophysical Journal*.

"This is a very exciting step forward to view the inner region of a distant galaxy with such fine detail," said Gail Schaefer, Associate Director of the Center for High Angular Resolution Astronomy (CHARA) Array.

A supermassive black hole is thought to exist at the center of every large galaxy. As material in the surrounding region gets pulled toward the center, the gas forms a hot and bright disk-like structure. In some cases, a jet emerges from the vicinity of the black hole in a direction at a right angle to the disk. However, this flat structure, which is essentially the "engine" of this active [supermassive black hole](#) system, has never been directly seen because it's too small to be captured by conventional telescopes.

One way to approach this key structure is to directly see an outer "dusty ring"—interstellar gas contains [dust grains](#), tiny solid particles made of heavy elements, which can only survive in the outer region where temperature is low enough (

Attempts to see this structure from edge-on directions are difficult, because the system is obscured by the same dust acting as an absorber of light. Instead, in the new investigation the team focused on a system with a face-on view, the brightest such object in the nearby universe. However, the detection needed very high spatial resolution in the infrared wavelengths, and at the same time, a large [array](#) of telescopes that is laid out suitably to observe objects at different orientations.

The Georgia State University CHARA Array interferometer at the Mount Wilson Observatory in California is the only facility which meets both of these requirements. The Array consists of 6 telescopes, each of

which has a 1-meter diameter mirror, that are combined to achieve the spatial resolution of a much larger telescope.

While each individual telescope is relatively small, the array layout is optimized to observe objects in a variety of angles and with large distances between telescopes. This achieves a very high spatial resolution capability. The CHARA Array actually has the sharpest eyes in the world in infrared wavelengths.

With the CHARA Array, the team finally detected the dusty ring, at a right angle to the emerging jet in the center of the galaxy called NGC 4151.

"We've been hoping to see this structure in a bare nucleus object for a long, long time," says Makoto Kishimoto, principal investigator of the project at Kyoto Sangyo University.

A big boost was that each telescope has recently added a new system called "adaptive optics."

Matt Anderson, a postdoctoral researcher at the CHARA Array who played a critical role in conducting the observations, says, "This greatly increased the injection rate of the light, compensating for the relatively small collecting mirror to observe the extragalactic target, which is much fainter than the stellar targets typically observed in our galaxy."

Over the last nearly 40 years, researchers in the field believed that this dusty ring is a key to understanding different characteristics of accreting supermassive blackhole systems. The properties we observe depend on whether we have an obscured, edge-on view or clear, face-on view of the nucleus of the active galaxy. The detection of this ring-like structure validates this model.

Furthermore, the detection probably is not just an indication of a flat structure. Additional studies have been showing that the structure seen at slightly longer infrared wavelengths, corresponding to an even larger outer region, seems elongated along the jet, and not at a right angle to it. This has been interpreted as an indication for a dusty wind being blown out toward the jet direction.

The present finding that the inner structure looks flat and perpendicular to the jet, is an important link to the windy structure and its interaction with the rest of the galaxy surrounding the active black hole system.

These groundbreaking observations measured the size and orientation of the dusty disk. The team is working to get an even more detailed image of the central region by building a new instrument at the CHARA Array that can see deeper into space and resolve finer scale structure of the source.

More information: Makoto Kishimoto et al, The Dust Sublimation Region of the Type 1 AGN NGC 4151 at a Hundred Microarcsecond Scale as Resolved by the CHARA Array Interferometer, *The Astrophysical Journal* (2022). [DOI: 10.3847/1538-4357/ac91c4](https://doi.org/10.3847/1538-4357/ac91c4)

Provided by Georgia State University

Citation: CHARA Array detects elusive, dusty inner region of distant galaxy (2022, November 18) retrieved 21 September 2024 from <https://phys.org/news/2022-11-chara-array-elusive-dusty-region.html>

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