NuSTAR finds clumpy doughnut around black hole

December 17 2015

NuSTAR's view of NGC 1068. Credit: NASA / JPL-Caltech / Roma Tre Univ.

The most massive black holes in the universe are often encircled by thick doughnut-shaped disks of material. This doughnut material ultimately feeds and nourishes the growing black holes tucked inside. Until recently, some of these doughnuts were too thick for any telescopes to penetrate, but now a team of astronomers have used the NASA NuSTAR and ESA XMM-Newton X-ray observatories to peer inside. They publish their work in *Monthly Notices of the Royal Astronomical Society*.

"Originally, we thought that some black holes were hidden behind walls or screens of material that could not be seen through," said Andrea Marinucci, the lead author of the new study.

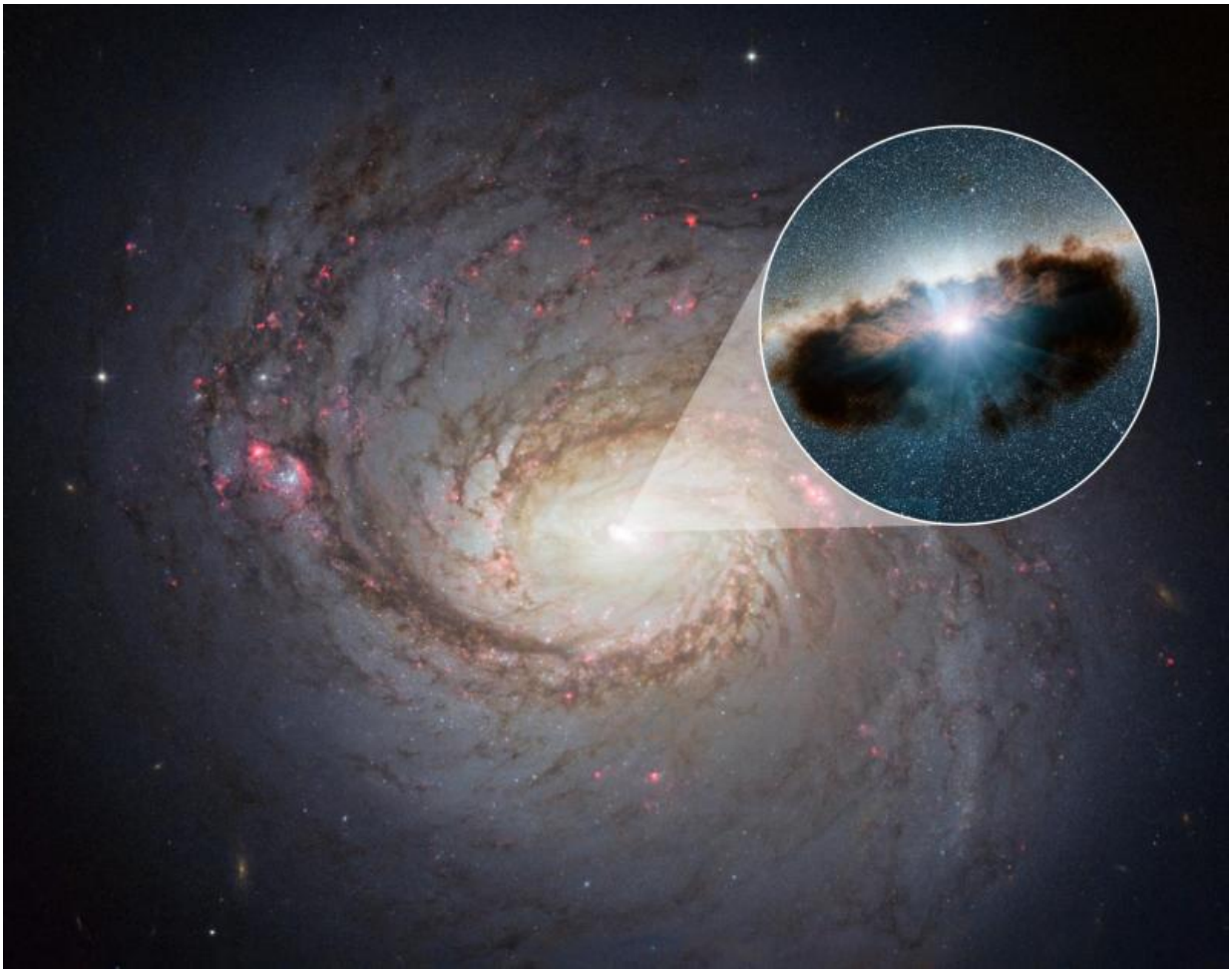
NuSTAR recently looked inside one of the densest doughnuts known around a supermassive black hole. This black hole lies at the centre of a well-studied spiral galaxy called NGC 1068, located 47 million light-years away in the direction of the constellation of Cetus.

The observations revealed a clumpy doughnut.

"The rotating material is not a simple doughnut as originally thought, but clumpy," said Marinucci.

Doughnuts around supermassive black holes were first proposed in the mid-80s to explain why some black holes are hidden behind gas and dust, while others are not. The idea is that the orientation of the doughnut relative to Earth affects the way we perceive a black hole and its intense radiation. If the doughnut is viewed edge-on, the black hole is blocked. If the doughnut is viewed face-on, the black hole and its

surrounding, blazing materials can be detected. This idea is referred to as the unified model because it neatly joins together the different black hole types, based solely upon orientation.



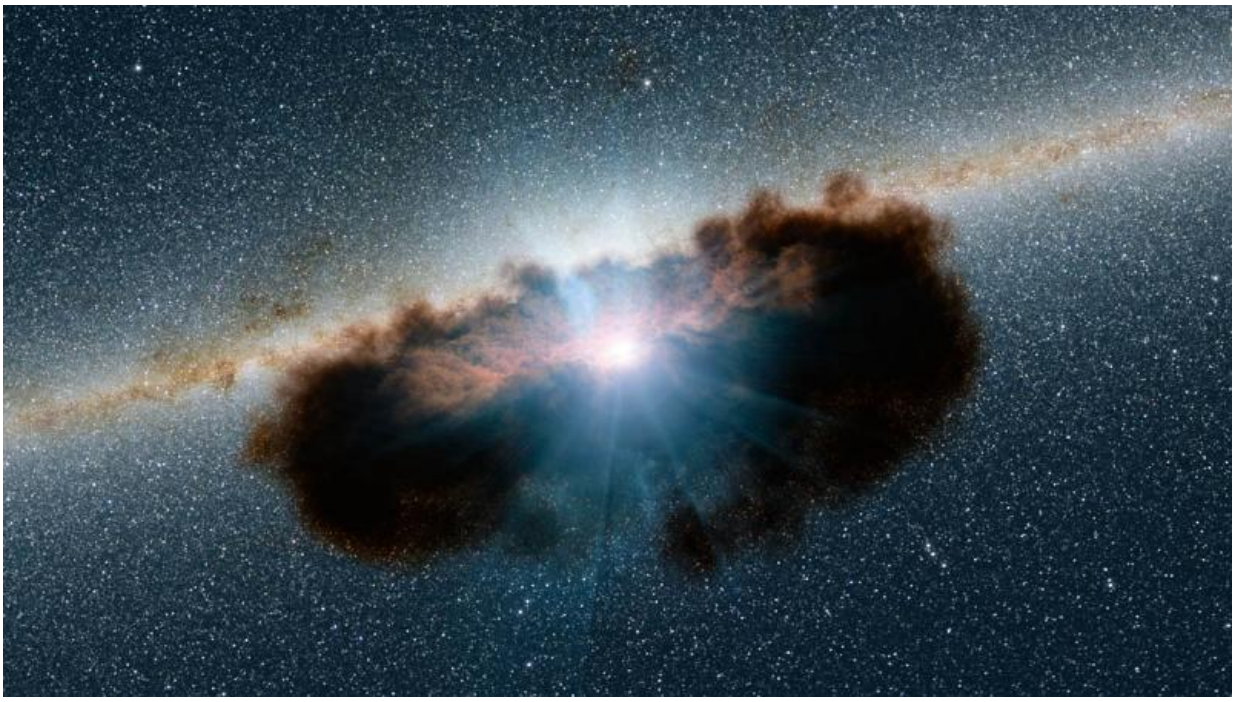
Hidden lair at the heart of NGC 1068. Credit: NASA / JPL-Caltech

In the past decade, astronomers have been finding hints that these doughnuts aren't as smoothly shaped as once thought. They are more like defect doughnuts with lumps, which a doughnut shop might throw in the trash.

The new discovery is the first time that this clumpiness has been observed in an ultra-thick doughnut, and supports the idea that this phenomenon may be common. The research is important for understanding the growth and evolution of massive black holes and their host galaxies.

"We don't fully understand why some supermassive black holes are so heavily obscured, or why they are clumpy," said co-author Poshak Gandhi of the University of Southampton in the United Kingdom. "This is a subject of hot research."

Both NuSTAR and XMM-Newton observed the supermassive black hole in NGC 1068 simultaneously on two separate occasions between 2014 and 2015. On one of those occasions, in August, 2015, NuSTAR observed a spike in brightness. NuSTAR observes higher-energy X-rays than XMM-Newton, and those high-energy X-rays can uniquely pierce thick clouds around the black hole. The scientists say that the spike in high-energy X-rays was due to a clearing in the thickness of the material entombing the supermassive black hole.



Galaxy 1068 in close-up from NASA's Hubble Space Telescope. Credit: NASA/JPL-Caltech

"It's like a cloudy day, when the clouds partially move away from the sun to let more light shine through," said Marinucci.

"NGC 1068 is well known to astronomers as the first black hole which gave birth to the unification idea. But it is only with NuSTAR that we now have a direct glimpse of its black hole through such clouds, albeit fleeting, allowing a better test of the unification concept," he said.

The team says that future research will address the question of what causes the unevenness in the doughnut material. The answer could come in many flavours. It's possible that a black hole generates turbulence as it chomps on nearby material. The energy given off by young stars could also stir up turbulence, which would then percolate outward through the

doughnut. Or, the clumps may be from material that falls onto the doughnut from outside it.

As galaxies form, material migrates toward the centre, where the density and gravity is greatest. The material tends to fall in clumps, almost like a falling stream of water condensing into droplets as it hits the ground.

"We'd like to figure out if the unevenness of the material is being generated from outside the doughnut, or within it," said Gandhi.

"These coordinated observations with NuSTAR and XMM-Newton show yet again the exciting science possible when these satellites work together," said Daniel Stern, the project scientist for NuSTAR at NASA's Jet Propulsion Laboratory in Pasadena, California.

More information: "NuSTAR catches the unveiling nucleus of NGC 1068", A. Marinucci, S. Bianchi, G. Matt, D. M. Alexander, M. Balokovi´c, F. E. Bauer, W. N. Brandt, P. Gandhi, M. Guainazzi, F. A. Harrison, K. Iwasawa11, M. Koss, K. K. Madsen, F. Nicastro, S. Puccetti, C. Ricci, D. Stern, D. J. Walton, Monthly Notices of the Royal Astronomical Society, Oxford University Press, in press.

Provided by Royal Astronomical Society

Citation: NuSTAR finds clumpy doughnut around black hole (2015, December 17) retrieved 27 April 2024 from https://phys.org/news/2015-12-nustar-clumpy-doughnut-black-hole.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.