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Dusty Surprise Around Black Hole Found By Physics Postdoctoral Fellow

New observations of a nearby active galaxy called NGC 3783 have given a team of astronomers — including a UC Santa Barbara postdoctoral fellow in physics — a surprise. The research, which focuses on the discovery of a dusty wind associated with the process of black hole formation, was presented in today's edition of the *Astrophysical Journal*.

Almost all galaxies have a huge black hole at their center. Some of them grow by drawing in matter from their surroundings, in the process creating active galactic nuclei (AGN), the most energetic objects in the universe. The central regions of these brilliant powerhouses are ringed by doughnuts of cosmic dust dragged from surrounding space in a fashion similar to how water forms a whirlpool around a sink drain. It was thought that most of the strong infrared radiation coming from AGN originated in these doughnuts. Although the hot dust — at some 700 to 1000 degrees Celsius — is indeed in a torus (a ring-shaped surface) as expected, the researchers found huge amounts of cooler dust above and below this main torus.

As UCSB postdoctoral fellow and lead author Sebastian Hoenig explained, "This is the first time we've been able to combine detailed mid-infrared observations of the cool, room-temperature dust around an AGN with similarly detailed observations of the very hot dust. This also represents the largest set of infrared interferometry for an AGN published yet." An interferometer is an array of telescopes acting together to probe structures with higher resolution.

The newly discovered dust forms a cool wind streaming outward from the black hole. This wind must play an important role in the complex relationship between the black hole and its environment. The black hole feeds its insatiable appetite from the surrounding material, but the intense radiation this produces also seems to be blowing the material away. It is still unclear how these two processes work together to allow supermassive black holes to grow and evolve within galaxies, but the presence of a cool, dusty wind in the polar regions adds a new piece to this picture.

In order to investigate the central regions of NGC 3783, the astronomers needed the combined power of the unit telescopes of European Southern Observatory (ESO)'s Very Large Telescope (VLT) at the Paranal facility in Chile's Atacama Desert. Using these units together forms an interferometer that can obtain a resolution equivalent to that of a 130-meter telescope.

Another team member, Gerd Weigelt of the Max-Planck Institute for Radioastronomy in Bonn, Germany, explains. "By combining the world-class sensitivity of the large mirrors of the VLT with interferometry we are able to collect enough light to observe faint objects," he said. "This lets us study a region as small as the distance from our Sun to its closest neighboring star in a galaxy tens of millions of light-years away. No other optical or infrared system in the world is currently capable of this."

According to the astronomers, these new observations may lead to a paradigm shift in the understanding of AGN. The findings are direct evidence that dust is being pushed out by the intense radiation. Models of how the dust is distributed and how supermassive black holes grow and evolve must now take into account this newly discovered effect.

Hoenig said he looks forward to MATISSE (the Multi AperTure mid-Infrared SpectroScopic Experiment), a second-generation instrument for the Very Large Telescope Interferometer, which will enable researchers to combine all four VLT unit telescopes at once and observe simultaneously in the near- and mid-infrared, thereby amassing much more detailed data. MATISSE is currently under construction at ESO's Paranal location.

The full research paper can be accessed at:

<https://www.eso.org/public/archives/releases/sciencepapers/eso1327/eso1327a.pdf>.

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