UC SANTA BARBARA

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# A New Kind of Black Hole Activity

Astrophysicist Andy Howell, an adjunct faculty member in the physics department at UC Santa Barbara and a staff scientist at Las Cumbres Observatory (LCO), and his colleagues have revealed a new kind of behavior associated with supermassive black holes. The Goleta-based observatory recently published the following announcement detailing the findings.

Supermassive black holes, the type at the centers of galaxies that are millions or billions times the mass of the Sun, were thought to eat and grow in only two ways: either by ripping apart a star in a Tidal Disruption Event (TDE), or by nearly continuous accretion from a disk of material as is seen in a quasar or radio galaxy - this phenomenon is known as Active Galactic Nuclei (AGN). In new research published today in Nature Astronomy, astronomers have seen several examples of a new **third** kind of flare, one longer lived than a star being ripped apart and not as constant as a quasar.

The new phenomenon was revealed by an international team of astronomers led by Benny Trakhtenbrot of Tel Aviv University in a *tour de force* of observations spanning observatories around the world and in space, including data from NASA's Swift and NuSTAR satellites, the NICER (Neutron star Interior Composition Explorer) instrument on the International Space Station, and Las Cumbres Observatory, a globe-spanning network of robotic telescopes.

In a normal AGN or quasar, the brightness of the center part of the galaxy fluctuates over many years as the black hole devours material from an accretion disk, similar

to water flowing down a bathtub drain. Material spins ever-more quickly as it approaches the black hole, causing it to glow in optical, ultraviolet light and x-rays. In a Tidal Disruption Event, a star is ripped apart by the black hole, causing a large single spike in brightess that only lasts for a few months. In the new class of flares, the area around the black hole increases in optical and ultraviolet emission by about 50%, and in x-rays by factors of several, for more than a year before fading.

The new finding began with the discovery of Astronomical Transient AT 2017bgt by the ASAS-SN network of telescopes. Soon after, astronomers at Las Cumbres Observatory started monitoring the transient with their network of ground-based telescopes and noticed behavior never before seen. The team also triggered space-based observations to observe the ultraviolet and x-ray properties, as photons at those high energies are blocked by the Earth's atmosphere. Later, they found another two other examples of similar phenomena around other supermassive black holes in other galaxies, establishing it as a new class of black hole feeding.

Andy Howell, staff scientist at LCO and a coauthor on the study said, "It is remarkable to have three different x-ray facilities in orbit, Swift, NICER, and NuSTAR, working together to help us see the extraordinarily high energies radiated near this black hole. But they only tell part of the story. Long-term ground-based monitoring was also necessary to have observations that stretch over more than a year, and that's exactly what LCO was built for."

Howell draws an analogy with water: "An AGN is like getting rained on -- a constant trickle that might vary a bit in intensity, but lasts for a while. A tidal disruption event is like getting hit by a sprinkler -- there's just one stream of water, and it might be more intense than rain. But this new kind of flare is like getting hit by a firehose in the face. Now we have to figure out, 'How the hell did nature produce that that?' Black holes are even weirder than we thought."

Astronomers are confounded as to how a stream of material apparently bigger than a star flows around the black hole to produce such emission. As it is the first time such a phenomenon has been seen, it has not yet been simulated.

Since it remains unknown how black holes grow in size from something only a few times the mass of the sun up to, in the case of AT 2017bgt, 14-million times the mass of the Sun, astronomers are excited to get any new insight into the process of how black holes eat and grow. "We are trying to find all the different ways black

holes gain mass with LCO at the center of this effort," says Iair Arcavi, formerly a postdoc at LCO and now a faculty member at Tel Aviv University and a co-author on the study, "maybe now we'll finally solve the riddle of how nature makes these monsters that lie at the center of every galaxy."

The paper can be found at Nature Astronomy here.

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