Hotspot discovery proves Canadian astrophysicist's black hole theory

October 31 2018

The recent detection of flares circling black holes has proven a decade-old theory co-developed by a Canadian physicist about how black holes grow and consume matter.

"It's extremely exciting to see our theoretical musing come to life and that tracking these types of flares about black holes is possible," said Avery Broderick, an Associate Faculty member at Perimeter Institute and the University of Waterloo, who predicted the flares 13 years ago with collaborator Avi Loeb.

Recently, a discovery by the GRAVITY Collaboration has detailed the detection of three flares—visual hotspots—emanating from a black hole known as Sagittarius A*, or Sgr A*. The team detected a wobble of emissions coming from the flares, enabling the scientists to detect the growing orbit, known as an accretion disk, of the black hole itself.

The idea of using the emissions from visual hotspots to map the behaviour of black holes was first suggested by Broderick and Loeb in 2005 when both were working at the Harvard-Smithsonian Center for Astrophysics (CfA).

The pair's 2005 paper and a 2006 follow-up outlined computer models and highlighted their proposal that the flares were being caused by the confluence of two extreme events: the bending of light around the black hole and the generation of hot spots by magnetic reconfigurations, known as magnetic reconnection, which accelerated charged particles to relativistic speeds around Sgr A*. They showed how the hotspots could be used as visual probes to trace out structures in the accretion disk and spacetime itself.

"Black holes are gravitational masters of their domain, and anything that drifts too close will be blended into a superheated disk of plasma surrounding them," said Broderick. "The matter trapped in the black hole's growing retinue then flows towards the event horizon—the point at which no light can escape—and consumed by the black hold via mechanisms that aren't yet fully understood.

"We believed if flare timescales were close to orbital timescales around a black hole, they could actually represent bright features that were embedded within the accretion disk and help us understand the behaviour and growth of black holes," said Broderick.

The study, published today in *Astronomy and Astrophysics*, detected the flares emanating from Sgr A* earlier this year on the European Southern Observatory's Very Large Telescope in Chile. While the hotspots couldn't be fully revolved using the telescope, The GRAVITY Collaboration recognized the wobble of emission from the flares as the associated hotspots orbited the supermassive black hole.

"The lives of black holes have become substantially more clear today. My hope is that the same features seen by GRAVITY will be imaged in the near future, allowing us to unlock the nature of gravity. I'm optimistic that we won't have long to wait," said Broderick.

More information: "Detection of Orbital Motions Near the Last Stable Circular Orbit of the Massive Black Hole SgrA*," GRAVITY Collaboration, 2018 Oct. 31, *Astronomy & Astrophysics*

Provided by University of Waterloo