Impact of black hole winds, radiation examined in new study

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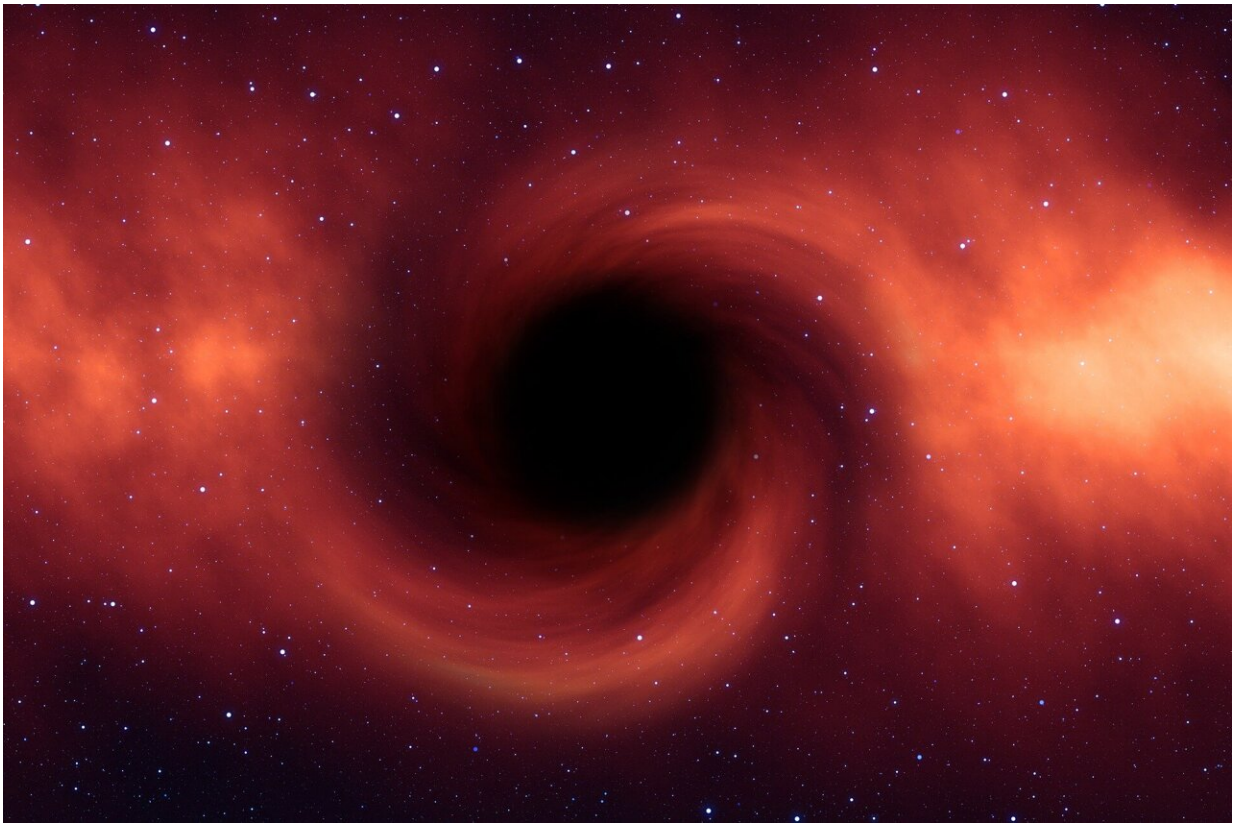

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Black holes are regions of space where gravity is so strong that nothing can escape. New research is examining the radiation and winds emanating from black hole activity and shows how they may exert

effects on nearby planets.

"The impact of AGN outflows on the surface habitability of terrestrial planets in the Milky Way" is a research paper by the team of astrobiologist Manasvi Lingam and astrophysicist Eric Perlman from Florida Tech's Department of Aerospace, Physics and Space Sciences, as well as researchers from the University of Rome, University of Maryland and Goddard Space Flight Center. Published in the *Monthly Notices of the Royal Astronomical Society*, the paper examines the effects of the supermassive black hole at our galaxy's center on the atmosphere of planets in the Milky Way. The paper focuses on two key mechanisms: how black hole winds can heat atmospheres and drive atmospheric escape, as well as how they can stimulate the formation of nitrogen oxides and thus lead to ozone depletion.

To study how black holes can affect a planet's atmosphere, the team developed mathematical models to estimate the maximal distance up to which these effects are rendered significant for Earth-like planets in the Milky Way. This demonstrated that this value may extend approximately over 3,000 lightyears. In the case of quasars hosting larger supermassive black holes, the research found such effects could actually influence the black hole's host galaxy as a whole.

"It turns out that when you have a supermassive black hole that is active, it not only produces radiation, but it also produces a lot of high energy particles that are powered by the black hole," Lingam said. "It is easy to visualize it as a fast-moving wind, like an extremely amplified hurricane. You have this wind of high energy particles that is emanating from the black hole's vicinity at 10% the speed of light, more than thousand times faster than our current spacecraft."

The radiation emitting from the black holes is essentially the particles of light known as photons. But if black holes are mainly known for nothing

escaping out of them, why is this light being emitted as well as the high-energy particles in the wind? What happens is there is a lot of gas that surrounds the black hole during its active phase. The black hole starts eating up some of that gas. But it doesn't eat it up in a totally efficient way: as the black hole is consuming more and more gas, the gas is falling in towards the black hole.

While it is falling inward towards the black hole, it's getting heated. Much like when you rub your hands together and the friction generates heat, the friction experienced by the gas spiraling inwards towards the black hole leads to it getting heated and eventually releasing energy in the form of photons.

Think of it as a form of interstellar indigestion, Lingam said.

"This radiation can bombard the atmospheres," he said. "It can lead to those atmospheres getting eroded away. It can supply lots of UV radiation, it can be harmful to biology and so on. Some of the same ramifications apply to the high-speed winds from the black hole as well. These were some of the many effects that we looked at."

There's still a lot of black hole wind research that remains to be done. Lingam noted that the model considers the uniform expansion of wind throughout space, whereas future work would need to examine the emission of radiation and winds in the form of jets, which he hopes to investigate with Perlman and his Italian colleagues.

For those who are worried about radiation and winds from the Milky Way's supermassive black hole affecting Earth, there is no reason to be concerned.

"The good thing which we learned during the course of this work is that a lot of these effects extend up to 3,000 light-years, maybe 5,000 light

years, in some extreme cases," Lingam said. "But the earth fortunately is located 26,000 light years from the center of the Milky Way, so it's comfortably outside that zone of influence, if we can call it that, of the black hole activity. Therefore, we might consider ourselves fortunate to inhabit this relatively peaceful region of our galaxy."

More information: A Ambrifi et al, The impact of AGN outflows on the surface habitability of terrestrial planets in the Milky Way, *Monthly Notices of the Royal Astronomical Society* (2022). DOI: 10.1093/mnras/stac542

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