Water circling drain experiments offer insight into black holes

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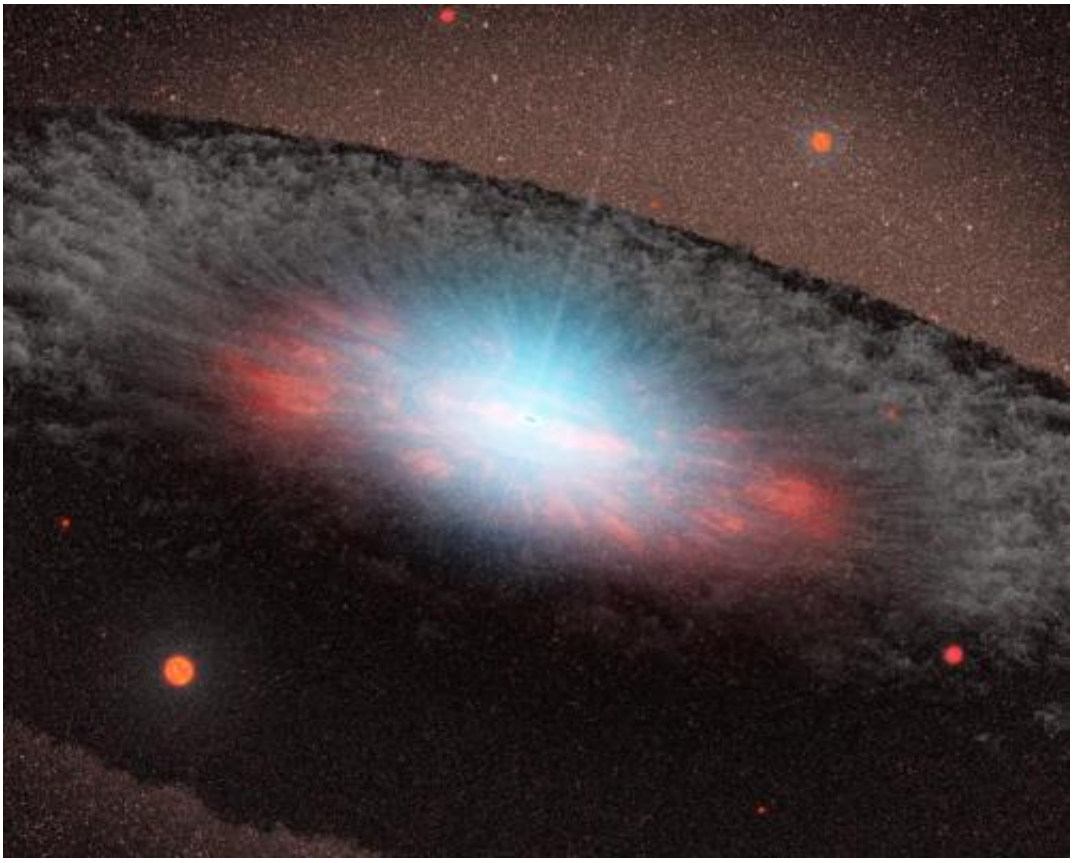

This artist's concept depicts a supermassive black hole at the center of a galaxy. The blue color here represents radiation pouring out from material very close to the black hole. The grayish structure surrounding the black hole, called a torus, is made up of gas and dust. Credit: NASA/JPL-Caltech

A small international team of researchers has found that water waves

created due to scattering from a spinning vortex can show rotational superradiance—an effect astrophysicists have predicted likely to occur in black holes, but which has never been replicated in a lab experiment. In their paper published in the journal *Nature Physics,* the group explains how they observed and measured waves propagating on the surface of water near a draining vortex and what they found.

As the researchers explain, when a wave strikes an obstacle, it tends to scatter, as can be observed at virtually any seashore. But more difficult to see is that some of the wave is reflected as well as partially transmitted. This led to a theory back in 1954 by Robert Dicke that suggests if an object is spinning, the waves can be amplified by extracting energy from the parts of the wave that are scattered—a phenomenon called superradiance. In this new effort, the researchers conducted experiments designed to prove the theory correct.

The experiments consisted of placing water in a 3 x 1.5 meter tank with a 4 cm hole at the center to serve as a drain—the researchers took measurements of wave activity by sensors mounted on the side of the tank (and by a high-speed, three-dimensional air–fluid interface sensor) as pumped-in water was drained, creating a vortex. The researchers report that they observed waves propagating on the surface and that measurements confirmed the waves were amplified after scattering occurred. They further report that the largest amplification recorded was 14 percent +/– 8 percent with waves of 3.70Hz in water that was just 6.25 cm deep. They claim their findings agree with theory, and therefore that their findings can be applied to research surrounding black holes. This is because they believe the scattering of shallow waves on water is analogous to the action that occurs at the event horizon of a black hole. They also note that new, more sensitive gravitational wave detectors might someday be able to measure roughly the same behavior with real black holes.

Press release from University of Nottingham

More information: Theo Torres et al. Rotational superradiant scattering in a vortex flow, *Nature Physics* (2017). DOI: 10.1038/nphys4151