Physicist claims to have observed quantum effects of Hawking radiation in the lab for the first time

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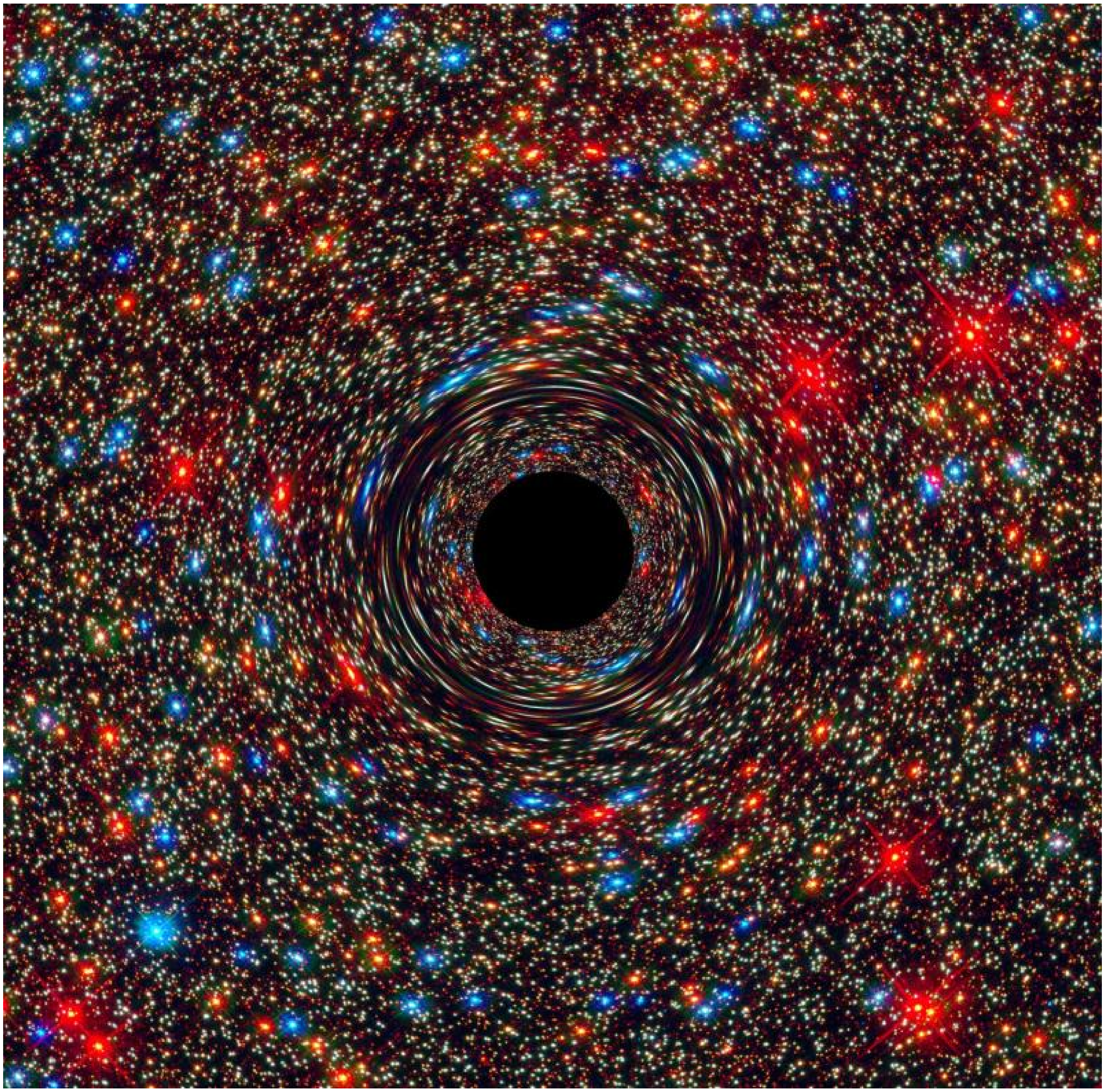

This computer-simulated image shows a supermassive black hole at the core of a galaxy. The black region in the center represents the black hole's event horizon, where no light can escape the massive object's gravitational grip. The black hole's powerful gravity distorts space around it like a funhouse mirror. Light from background stars is stretched and smeared as the stars skim by the black hole. Credit: NASA, ESA, and D. Coe, J. Anderson, and R. van der Marel (STScI)

(Phys.org)—Jeff Steinhauer, a physicist at the Israel Institute of Technology, has published a paper in the journal *Nature Physics* describing experiments in which he attempted to create a virtual black hole in the lab in order to prove that Stephen Hawking's theory of radiation emanating from black holes is correct —though his experiments are based on sound, rather than light. In his paper, he claims to have observed the quantum effects of Hawking radiation in his lab as part of a virtual black hole—which, if proven to be true, will be the first time it has ever been achieved.

For many years, scientists believed that nothing could ever escape from a black hole. But in 1974, Stephen Hawking published a paper suggesting that something could—particles that are now called Hawking radiation. His idea was that if a particle (and its antimatter mate) appeared spontaneously at the edge of a black hole, one of the pair might be pulled into the black hole while the other escaped, taking some of the energy from the black hole with it—which would explain why black holes grow smaller and eventually disappear. Because such emissions are so feeble, no one has been able to measure Hawking radiation, so researchers have instead tried to build virtual black holes in labs to test the theory. One type of virtual black hole was proposed back in 1981 by Bill Unruh with the University of British Columbia—he suggested that an analogue might be created using water instead of light. He imagined a phonon existing at the edge of a waterfall—as the water speeds up, it begins to move faster than the speed of sound, causing it to be trapped. But if the phonon had an entangled mate that eluded the fall by moving away before getting caught up, it could escape. In this new effort, Steinhauer has built a device based on that idea and in so doing, claims he has observed an analogue of Hawking radiation.

The experiment consisted of creating an entangled pair of phonons sitting inside a bit of liquid that had been forced (via laser) to move very fast and then observing the action as one of the pair was pulled away as the liquid began to move faster than the speed of sound, while the other escaped—the fluid was a Bose-Enistein condensate of rubidium-87 atoms. After repeating the experiment 4,600 times Steinhauer became convinced that the particles were entangled, a necessity for a Hawking radiation analogue. His findings do not prove Hawking's theory to be true, of course, but they do appear to add a degree of credence that other researchers have thus far not been able to achieve.

More information: Jeff Steinhauer. Observation of quantum Hawking radiation and its entanglement in an analogue black hole, *Nature Physics* (2016). DOI: 10.1038/nphys3863

Abstract

We observe spontaneous Hawking radiation, stimulated by quantum vacuum fluctuations, emanating from an analogue black hole in an atomic Bose–Einstein condensate. Correlations are observed between the Hawking particles outside the black hole and the partner particles inside. These correlations indicate an approximately thermal distribution of Hawking radiation. We find that the high-energy pairs are entangled, while the low-energy pairs are not, within the reasonable assumption that excitations with different frequencies are not correlated. The entanglement verifies the quantum nature of the Hawking radiation. The

results are consistent with a driven oscillation experiment and a numerical simulation.

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