

# Plugging the hole in Hawking's black hole theory

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Professor Chris Adami, Physics and Astronomy. Credit: G.L. Kohuth

(Phys.org) —Recently physicists have been poking holes again in Stephen Hawking's black hole theory – including Hawking himself. For decades physicists across the globe have been trying to figure out the mysteries of black holes – those fascinating monstrous entities that have such intense gravitational pull that nothing – not even light – can escape from them. Now Professor Chris Adami, Michigan State University, has

jumped into the fray.

The debate about the behavior of black holes, which has been ongoing since 1975, was reignited when Hawking posted a blog on Jan. 22, 2014, stating that event horizons – the invisible boundaries of black holes – do not exist.

Hawking, considered to be the foremost expert on black holes, has over the years revised his [theory](#) and continues to work on understanding these cosmic puzzles.

One of the many perplexities is a decades-old debate about what happens to information – matter or energy and their characteristics at the atomic and subatomic level – in black holes.

"In 1975, Hawking discovered that [black holes](#) aren't all black. They actually radiate a featureless glow, now called Hawking radiation," Adami said. "In his original theory, Hawking stated that the radiation slowly consumes the black hole and it eventually evaporates and disappears, concluding that information and anything that enters the black hole would be irretrievably lost."

But this theory created a fundamental problem, dubbed the information paradox. Now Adami believes he's solved it.

"According to the laws of quantum physics, information can't disappear," Adami said. "A loss of information would imply that the universe itself would suddenly become unpredictable every time the black hole swallows a particle. That is just inconceivable. No law of physics that we know allows this to happen."

So if the black hole sucks in information with its intense gravitational pull, then later disappears entirely, information and all, how can the laws

of quantum physics be preserved?

The solution, Adami says, is that the information is contained in the [stimulated emission](#) of radiation, which must accompany the Hawking radiation – the glow that makes a black hole not so black. Stimulated emission makes the black hole glow in the information that it swallowed.

"Stimulated emission is the physical process behind LASERS (Light Amplification by Stimulated Emission of Radiation). Basically, it works like a copy machine: you throw something into the machine, and two identical somethings come out.

"If you throw information at a black hole, just before it is swallowed, the black hole first makes a copy that is left outside. This copying mechanism was discovered by Albert Einstein in 1917, and without it, physics cannot be consistent," Adami said.

Do others agree with Adami's theory that stimulated emission is the missing piece that solves the information paradox?

According to Paul Davies, cosmologist, astrobiologist and theoretical physicist at Arizona State University, "In my view Chris Adami has correctly identified the solution to the so-called black hole information paradox. Ironically, it has been hiding in plain sight for years. Hawking's famous black hole radiation is an example of so-called spontaneous emission of radiation, but it is only part of the story. There must also be the possibility of stimulated emission -- the process that puts the S in LASER."

With so many researchers trying to fix Hawking's theory, why did it take so long if it was hiding in plain sight?

"While a few people did realize that the stimulated emission effect was

missing in Hawking's calculation, they could not resolve the paradox without a deep understanding of quantum communication theory," Adami said. Quantum communication theory was designed to understand how information interacts with quantum systems, and Adami was one of the pioneers of quantum information theory back in the '90s.

Trying to solve this information paradox has kept Adami awake many nights as demonstrated by his thick notebooks filled with 10 years of mathematical calculations.

So where does this leave us, according to Adami?

"Stephen Hawking's wonderful theory is now complete in my opinion. The hole in the black hole theory is plugged, and I can now sleep at night," he said.

Adami may now sleep well at night, but his theory is sure to keep other physicists up trying to confirm whether he has actually solved the mystery.

The study was co-authored by Greg Ver Steeg, University of Southern California and is published online in the journal *Classical and Quantum Gravity*.

Provided by Michigan State University

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