Possible way to test black hole information paradox in the lab

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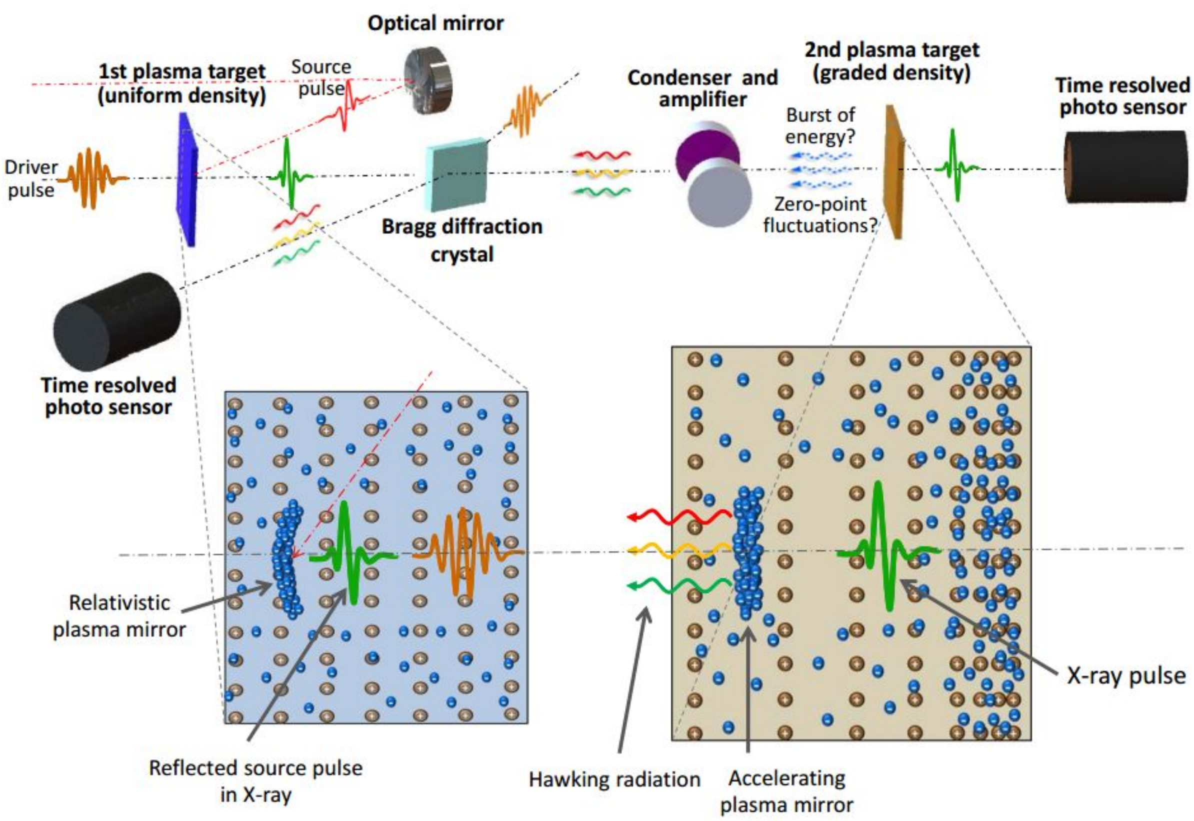

A schematic diagram of the proposed analog black hole experiment. The first, gaseous and uniform plasma target is used to prepare a high intensity x-ray pulse. The x-ray pulse will induce an accelerating plasma mirror due to the increasing plasma density in the second target. As the mirror stops abruptly, it will release either a burst of energy or zero-point fluctuations. The correlation function between either of these signals and the Hawking photons is measured upstream. Credit: arXiv:1512.04064 [gr-qc]

(Phys.org)—A pair of researchers, one with National Taiwan University, the other with École Polytechnique in France has come up with a way to test the idea of Hawking radiation and the information paradox in a lab setting. In their paper published in the journal *Physical Review Letters*, Pisin Chen and Gerard Mourou describe their idea and the likely difficulties that researchers would face in trying to carry out actual experiments.

The information paradox surrounding black holes came about as researchers pondered the problem of physical information being destroyed when it is pulled into a black hole and disappearing later as the black hole dies—this would seem to violate the laws of physics. Back in the 1970s, Stephen Hawking famously postulated the idea that if a pair of entangled photons came to exist near the event horizon and one was pulled into the black hole but the other escaped, then the escaping photon would hold the information, preventing its loss, thus avoiding a paradox. Since that time, physicists have conceived thought experiments to test this idea, but of course, due to the inability to travel to and test a black hole, all remain theoretical. In this new effort, the research pair believe they may have come up with a way to test one of those thought experiments in a lab here on Earth.

The thought experiment consisted of developing a way to mimic the behavior of the photons near the black hole event horizon—perhaps by generating entangled pairs of photons and then using an accelerating mirror to mimic the impact of black hole gravity. In this scenario, one photon would be reflected (representing Hawking radiation) while the other would not—it would keep moving until the mirror finally stopped.

To carry out this experiment, Chen and Mourou suggest a laser pulse could be sent through a plasma target. As it moves, it would create a wake consisting of electrons that could serve as a moving reflecting boundary. To keep the mirror accelerating, they also note, the plasma density would have to be continually increased. The two ran simple tests of the concept, and they now claim that carrying out such an experiment would be extremely difficult, though possible. It could be done, they suggest, using a next-generation particle accelerator called a plasma Wakefield accelerator.

More information: Pisin Chen et al. Accelerating Plasma Mirrors to Investigate the Black Hole Information Loss Paradox, *Physical Review Letters* (2017). DOI: 10.1103/PhysRevLett.118.045001 , On *Arxiv*: arxiv.org/abs/1512.04064

ABSTRACT
The question of whether Hawking evaporation violates unitarity, and therefore results in the loss of information, has remained unresolved since Hawking's seminal discovery. To date, the investigations have remained mostly theoretical since it is almost impossible to settle this paradox through direct astrophysical black hole observations. Here, we point out that relativistic plasma mirrors can be accelerated drastically and stopped abruptly by impinging intense x-ray pulses on solid plasma targets with a density gradient. This is analogous to the late time evolution of black hole Hawking evaporation. A conception of such an experiment is proposed and a self-consistent set of physical parameters is presented. Critical issues, such as how the black hole unitarity may be preserved, can be addressed through the entanglement between the analog Hawking radiation photons and their partner modes.