Researchers may have solved information loss paradox to find black holes do not form

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"Nothing there," is what Case Western Reserve University physicists concluded about black holes after spending a year working on complex formulas to calculate the formation of new black holes. In nearly 13 printed pages with a host of calculations, the research may solve the information loss paradox that has perplexed physicists for the past 40 years.

Case physicists Tanmay Vachaspati, Dejan Stojkovic and Lawrence M. Krauss report in the article, "Observation of Incipient Black Holes and the Information Loss Problem," that has been accepted for publication by *Physical Review D*.

"It's complicated and very complex," noted the researchers, regarding both the general problem and their particular approach to try to solve it.

The question that the physicists set out to solve is: what happens once something collapses into a black hole" If all information about the collapsing matter is lost, it defies the laws of quantum physics. Yet, in current thinking, once the matter goes over the event horizon and forms a black hole, all information about it is lost.

"If you define the black hole as some place where you can lose objects, then there is no such thing because the black hole evaporates before anything is seen to fall in," said Vachaspati.

The masses on the edge of the incipient black hole continue to appear into infinity that they are collapsing but never fall over inside what is known as the event horizon, the region from which there is no return, according to the researchers.

By starting out with something that was nonsingular and then collapsing that matter, they were determined to see if an event horizon formed, signaling the creation of a black hole.

The mass shrinks in size, but it never gets to collapse inside an event horizon due to evidence of pre-Hawking radiation, a non-thermal radiation that allows information of the nature of what is collapsing to be recovered far from the collapsing mass.

"Non-thermal radiation can carry information in it unlike thermal radiation. This means that an outside observer watching some object collapse receives non-thermal radiation back and may be able to reconstruct all the information in the initial object and so the information never gets lost," they said.

According to the researchers, if black holes exist, information formed in the initial state would disappear in the black hole through a burst of thermal radiation that carries no information about the initial state.

Using the functional Schrodinger formalism, the researchers suggest that information about the energy from radiation is long evaporated before an event horizon forms.

"An outside observer will never lose an object down a black hole," said Stojkovic. "If you are sitting outside and throwing something into the black hole, it will never pass over but will stay outside the event horizon even if one considers the effects of quantum mechanics. In fact, since in quantum mechanics the observer plays an important role in measurement, the question of formation of an event horizon is much more subtle to consider."

The physicists are quick to assure astronomers and astrophysicists that what is observed in gravity pulling masses together still holds true, but what is controversial about the new finding is that "from an external viewer's point it takes an infinite amount of time to form an event horizon and that the clock for the objects falling into the black hole appears to slow down to zero," said Krauss, director of Case's Center for Education and Research in Cosmology.

He continued "this is one of the factors that led us to rethink this problem, and we hope our proposal at the very least will stimulate a broader reconsideration of these issues."

If black holes exist in the universe, the astrophysicists speculate they were formed only at the beginning of time.

Source: Case Western Reserve University