

How physics breaks down in a black hole

June 24 2021



An artist's conception illustrates one of the most primitive supermassive black holes known (central black dot) at the core of a young, star-rich galaxy. Credit: NASA/JPL-Caltech

One of the most cherished laws of physics—the conservation of charge—has come under fire in "startling" research by physicists.

The <u>paper</u> by Dr. Jonathan Gratus from Lancaster University and Dr. Paul Kinsler and Professor Martin McCall from Imperial College London demonstrates how the <u>laws of physics</u> break down in a black hole or "singularity."

"As the place where <u>physics</u> 'breaks down' in a black-hole, we have the sense that anything might happen at a singularity. Although perhaps most useful as a plot device for science fiction stories, should we as concerned



physicists nevertheless check what conservation laws might no longer hold?"

The physicists investigated the behavior of charge conservation which is the principle that the total electric charge in an isolated system never changes.

To their surprise, they found that they could overturn this "usually sacrosanct principle of standard electromagnetism."

Dr. Kinsler said: "By dropping an 'axion-bomb' into a temporary singularity, such as an evaporating black hole, we can create or destroy electrical charge."

Axions are a hypothesized particle that are a candidate for dark matter, although their exact properties are still debated, and they have not yet been detected.

Professor Martin McCall said: "This so-called axion-bomb is a mathematical construct that combines <u>electromagnetic fields</u> and axion particle fields in the correct way."

Dr. Jonathan Gratus said: "The construction shrinks and disappears into the singularity, taking electrical charge with it. And it is the combination of a temporary singularity and a newly proposed type of axion field that is crucial to its success."

Dr. Kinsler added: "Although people often like to say that physics 'breaks down," here, we show that although exotic phenomena might occur, what actually happens is nevertheless constrained by the stillworking laws of physics around the <u>singularity</u>."

The researchers said: "Our conclusion appears to be at once startling and



undeniable: global charge conservation cannot be guaranteed in the presence of axionic electromagnetic interaction."

More information: Jonathan Gratus et al, Temporary Singularities and Axions: An Analytic Solution that Challenges Charge Conservation, *Annalen der Physik* (2021). DOI: 10.1002/andp.202000565

Provided by Lancaster University

Citation: How physics breaks down in a black hole (2021, June 24) retrieved 3 May 2024 from <u>https://phys.org/news/2021-06-physics-black-hole.html</u>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.