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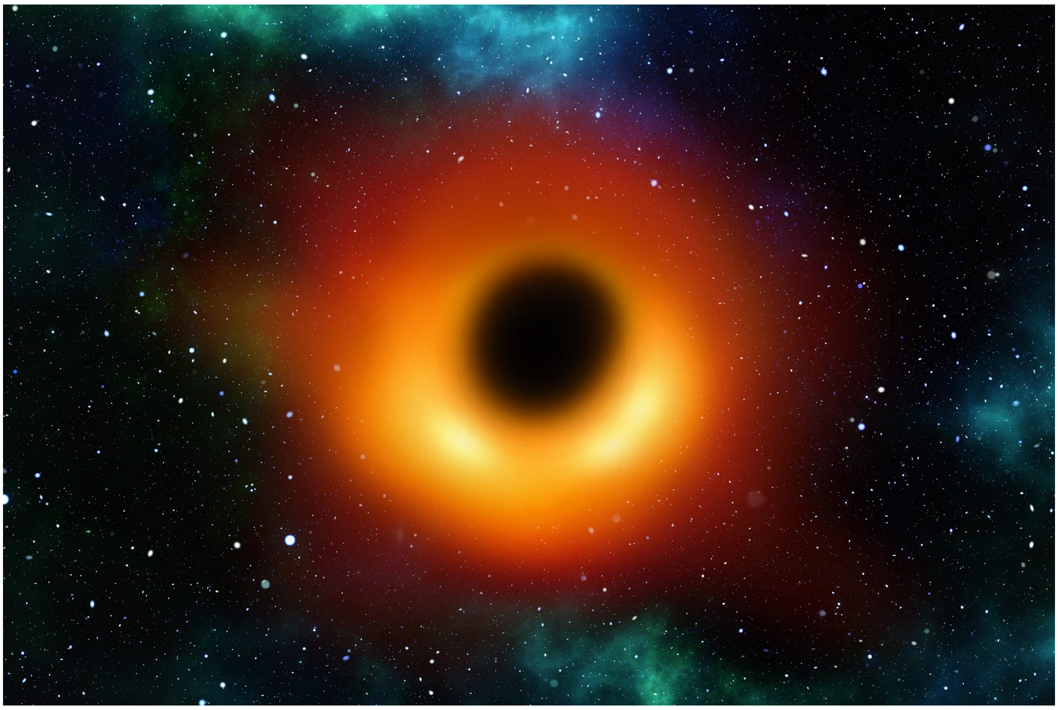
PRESS RELEASE

Not all Black Holes are the same

A new study of SISSA, IFPU, INFN Trieste and University of Nottingham published in Physical Review Letters shows that Black Holes could develop new features when they spin fast enough



07 December 2020

Despite Conventional wisdom suggests that black holes are fully characterized by just two quantities, mass and spin, for several years physicists have been investigating whether black holes can have additional structures - in jargon "hair" - which would reveal the existence of new fundamental fields.

“In our work we have considered a wide class of extensions to Einstein’s theory of gravity that make interesting prediction in extreme regimes, such as the surroundings of black holes or neutron stars” says Alexandru Dima, Astrophysicist of SISSA and INFN – Istituto Nazionale di Fisica Nucleare, Sezione di Trieste, first author of the paper *Spin-induced black hole spontaneous scalarization*, recently published in *Physical Review Letters*. “While previous studies have already provided examples of “hairy” black hole solutions, we have shown for the first time, thanks to numerical simulations, that black holes can spontaneously grow the simplest form of permanent hair (a scalar field) once they start spinning fast enough.”

Extensions of General Relativity

Together with Enrico Barausse (SISSA and IFPU - Institute for Fundamental Physics of the Universe and CNRS & Sorbonne University), Nicola Franchini (SISSA and IFPU) and Thomas P. Sotiriou (University of Nottingham, UK), Dima also describes the way in which rotation controls the hair growth mechanism. In Einstein’s theory of gravity and many of its extensions, mathematical theorems ensure that black holes cannot sustain hair. They eventually shed it away through the emission of gravitational waves. However, in the theories considered by Dima et al., once the black hole start rotating faster than a certain threshold it forces hair to grow, giving the black hole novel features.

Physicists have been investigating possible extensions of General Relativity in order to solve theoretical issues linked to the ongoing search for a quantized theory of gravity or as potential explanations of the puzzles that still await in the “dark side” of gravitational physics, like dark energy or dark matter. This discovery shows that evidence for a deviation from Einstein’s theory could be there, but only if one looks for it at the right type of black holes.

Professor Thomas Sotiriou led the research at the University of Nottingham Nottingham with support from PhD student Nicola Franchini who is now in a postdoctoral position at SISSA and IFPU. Professor Sotirou says: “Our results demonstrate that new physics can be quite elusive and only make an appearance when one looks carefully at the right type of black holes.”

Collecting clues for future experiments

The results also offer additional theoretical indications for future experiments. “In particular” continues Dima, “our result suggests that, depending on the rotational velocity of the objects involved, the gravitational waves produced as a consequence of the merger of black hole binary systems might be consistently different from what was previously expected.

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In the near future, an observation of such an effect or lack thereof by gravitational-wave experiments would consequently allow us to falsify a wide class of alternative theories of gravity, or possibly discover novel hints of new physics beyond General Relativity".

USEFUL LINK
Full paper:
https://link.aps.org/doi/10.1103/PhysRevLett.125.231101

IMAGE
Credits: Afbeelding van Gerd Altmann via Pixabay

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