Astronomers propose a new method for detecting black holes

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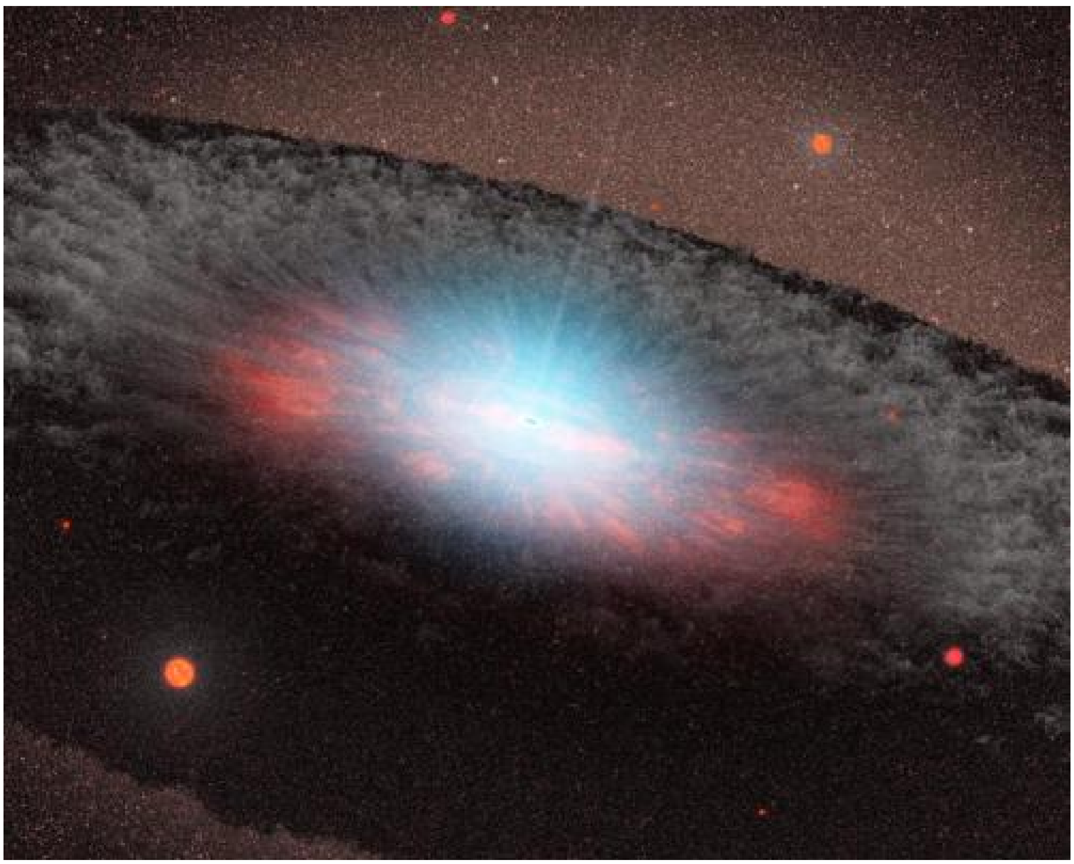

This artist's concept depicts a supermassive black hole at the center of a galaxy. The blue color here represents radiation pouring out from material very close to the black hole. The grayish structure surrounding the black hole, called a torus, is made up of gas and dust. Credit: NASA/JPL-Caltech

A stellar mass black hole is a compact object with a mass greater than three solar masses. It is so dense and has such a powerful force of attraction that not even light can escape from it. They cannot be observed directly, but only via secondary effects—for instance, in the case of a black hole feeding on a companion star. In general, when matter falls onto a black hole it does so "quietly" by way of an accretion disc. However, there are periods when this infall is violent and bursts, producing a strong outburst of X-ray brightness.

Binary systems composed of a star donating mass to a black hole are essential laboratories for the understanding of the most extreme physical phenomena in the universe, such as such as the collapse of a massive star into a black hole or a neutron star. Until now, some 60 candidates for this type of black hole have been found in the Milky Way via the detection of transient eruptions of X-rays, but only 17 of these have been confirmed. This is due to the difficulties inherent in studying the motion of a companion star around a black hole in order to infer its mass and confirm the type of object.

Researchers have only a limited knowledge of the formation and the evolution of this type of object because of the small number of known binaries containing a black hole. Thus, it is important to develop new strategies to discover the hidden population of objects that are not in an active phase, and are thus not emitting X-rays.

The IAC researchers Jorge Casares, and Miguel A. Pérez Torres have tested a novel technique measuring the brightness of these binary pairs with a combination of filters centred on the line of hydrogen H-alpha. The measurements give information about the intensity and the width of this line, which forms in the accretion disc around the black hole. In particular, the width of H-alpha can be used as an indicator of the strength of the gravitational field, and so can be used as a diagnostic of the presence of a black hole. This technique could efficiently reveal new black hole binaries in an inactive phase.

To demonstrate the utility of their technique, they observed four systems with confirmed black holes using a set of special filters on ACAM, an instrument on the 4.2-meter William Herschel Telescope (WHT) of the Isaac Newton group of Telescopes at the Roque de los Muchachos Observatory (Garafía, La Palma). The results were then compared with direct measurements of the width of the H-alpha line obtained with the ISIS spectrograph on the Gran Telescopio de Canarias (GTC). The result showed that it is practical to measure the width of the H-alpha line using photometric techniques, which opens the door to a more efficient detection of inactive black holes in binary systems.

They estimate that an analysis of some 1000 square degrees (10 percent) of the zone of the galactic plane with this strategy should detect at least 50 new objects of this type, which is three times the currently known population. This search could also yield a detailed census of other galactic populations, such as short period cataclysmic variables, X-ray binaries containing neutron stars, and ultra-compact binaries with period shorter than one hour.

More information: Jorge Casares et al. A feasibility study on the photometric detection of quiescent black hole X-ray binaries, *Monthly Notices of the Royal Astronomical Society* (2018). DOI: 10.1093/mnras/sty2570

Jorge Casares. Hibernating black holes revealed by photometric mass functions, *Monthly Notices of the Royal Astronomical Society* (2017). DOI: 10.1093/mnras/stx2690

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