

Intense wind found in the neighborhood of a black hole

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An artistic view of the accretion disc surrounding the black hole V404 Cygni, where the intense wind detected by GTC becomes evident. Credit: Gabriel Pérez, SMM (IAC).

An international team of astrophysicists, including Professor Phil Charles from the University of Southampton, have detected an intense wind from one of the closest known black holes to the Earth.



During observations of V404 Cygni, which went into a bright and violent outburst in June 2015 after more than 25 years of quiescence, the team began taking optical measurements of the black hole's accretion disc using the 10.4m Gran Telescopio CANARIAS (GTC) - the biggest optical-infrared telescope in the world, situated at the Roque de los Muchachos Observatory (Garafía, La Palma) in the Canary Islands.

The results, which are published today in *Nature*, show the presence of a wind of neutral material (unionised hydrogen and helium), which is formed in the outer layers of the accretion disc, regulating the accretion of material by the black hole. This wind, detected for the first time in a system of this type, has a very high velocity (3,000 kilometres per second) so that it can escape from the gravitational field around the black hole.

Professor Charles, from Physics and Astronomy at the University of Southampton, said: "Its presence allows us to explain why the outburst, in spite of being bright and very violent, with continuous changes in luminosity and ejections of mass in the form of jets, was also very brief, lasting only two weeks."

At the end of this outburst the GTC observations revealed the presence of a nebula formed from material expelled by the wind. This phenomenon, which has been observed for the first time in a black hole, also allows scientists to estimate the quantity of mass ejected into the interstellar medium.

Teo Muñoz Darias, a researcher at the Instituto de Astrofísica de Canarias (IAC) and the lead author of the study (and also a former Marie Curie Fellow at Southampton), said: "The brightness of the source and the large collecting area of the GTC allowed us not only to detect the wind, but also to measure the variation of its properties on time-scales of minutes. The database obtained is probably the best ever observed for an



object of this kind.

"This outburst of V404 Cygni, because of its complexity and because of the high quantity and quality of the observations, will help us understand how <u>black holes</u> swallow material via their accretion discs."

"We think that what we have observed with the GTC in V404 Cygni happens, at least, in other black holes with large accretion discs," concluded Professor Charles and Jorge Casares from IAC, two of the discoverers of V404 Cygni in 1992, and co-authors of the study.

V404 Cygni is a black hole within a binary system located in the constellation of Cygnus. In such systems, of which less than 50 are known, a black hole of around 10 times the mass of the Sun is swallowing material from a very nearby star, its companion star. During this process material falls onto the black hole and forms an accretion disc, whose hotter, innermost zones emit in X-rays. In the outer regions, however, we can study the disc in visible light, which is the part of the spectrum observable with the GTC.

V404 Cygni, at only 8,000 light years away, is one of the closest known black holes to the Earth, and has a particularly large <u>accretion disc</u> (with a radius of about ten million kilometres), making its outbursts especially bright at all wavelengths (X-rays, visible, infrared and radio waves).

On 15 June 2015, V404 Cygni went into outburst after a quiescence of over 25 years. During this period its brightness increased one million fold in a few days, becoming the brightest X-ray source in the sky. The GTC began taking spectroscopic observations on 17 June via the activation of a "target of opportunity" programme, designed by IAC researchers for this kind of event.

The observations were made with the OSIRIS instrument on the GTC,



and were carried out during the two weeks of the outburst, in observing windows of one to two hours per night. In addition, the study included observations in X-rays by the INTEGRAL and SWIFT satellites, as well as data from the AMI radio-interferometer in the United Kingdom.

Nine of the series of data obtained during the night of 27 June were obtained with the GTC in the presence of His Majesty King Felipe VI of Spain, who attended the observations as part of the celebrations of the 30th anniversary of the Canary Island Observatories. The King was able to observe at first hand the exceptional range of phenomena exhibited by this black hole.

More information: T. Muñoz-Darias et al, Regulation of black-hole accretion by a disk wind during a violent outburst of V404 Cygni, *Nature* (2016). DOI: 10.1038/nature17446

Provided by University of Southampton

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