New method of measuring the mass of supermassive black holes

January 30 2013, by Julie Cooper

Galaxy NGC4526 - the purple areas show the cold molecular gas which coincides with the dusty disk

(Phys.org)—A new way of measuring the mass of supermassive black holes could revolutionise our understanding of how they form and help to shape galaxies.

The technique, developed by a team including Oxford University scientists, can spot the telltale tracer of carbon monoxide within the cloud of gas (mostly hydrogen) circling a supermassive black hole at the centre of a distant galaxy. By detecting the velocity of the spinning gas they are able to 'weigh' (determine the mass) of the black hole.

Detailed information on supermassive black holes, thought to be at the heart of most galaxies, is scarce: it has taken 15 years to measure the mass of just 60. The problem is that most other supermassive black holes

are too far away to examine properly even with the Hubble Space Telescope.

The new method, when combined with new telescopes such as ALMA (Attacama Large Millimetre/submillimetre Array), promises to extend this black hole 'weigh-in' to thousands of distant galaxies. It will also enable the study of black holes in spiral galaxies (similar to our own Milky Way), which are hard to target using currently available techniques.

A report of the research is published in this week's *Nature*.

The team demonstrated the new technique on the supermassive black hole at the centre of a galaxy, NGC 4526, in the constellation of Virgo. NGC 4526 was chosen as a test because it has been widely studied but the team believe the technique will work on a wide range of different galaxies.

Tim Davis of the European Southern Observatory, lead author of the paper, said: 'We observed carbon monoxide molecules in the galaxy we were monitoring using the Combined Array for Research in Millimetre-wave Astronomy (CARMA) telescope. With its super-sharp images we were able to zoom right into the centre of the galaxy and observe the gas whizzing around the black hole. This gas moves at a speed which is determined by the black-hole's mass, and the distance from it. By measuring the velocity of the gas at each position, we can measure the mass of the black hole.'

Dr Michele Cappellari of Oxford University's Department of Physics, an author of the paper, said: 'Because of the limitations of existing telescopes and techniques we had run out of galaxies with supermassive black holes to observe. Now with this new technique and telescopes like ALMA we will be able to examine the relationship between thousands of

more distant galaxies and their black holes giving us an insight into how galaxies and black holes co-evolve. Importantly our 'weigh-in' technique will work for all kinds of galaxies, including spiral galaxies which are particularly difficult to observe with previous techniques.'

Dr Martin Bureau of Oxford University's Department of Physics, an author of the paper, said: 'The ALMA telescope is now in the final stages of construction and our team is currently bidding for time to use it for our black hole survey. If all goes according to plan we could begin our survey by the end of this year.'

More information: A report of the research, entitled 'A black-hole mass measurement from molecular gas kinematics in NGC4526', is published in the journal *Nature*.
Paper: dx.doi.org/10.1038/nature11819

Provided by University of Hertfordshire