Study suggests black hole jets get their power from spin

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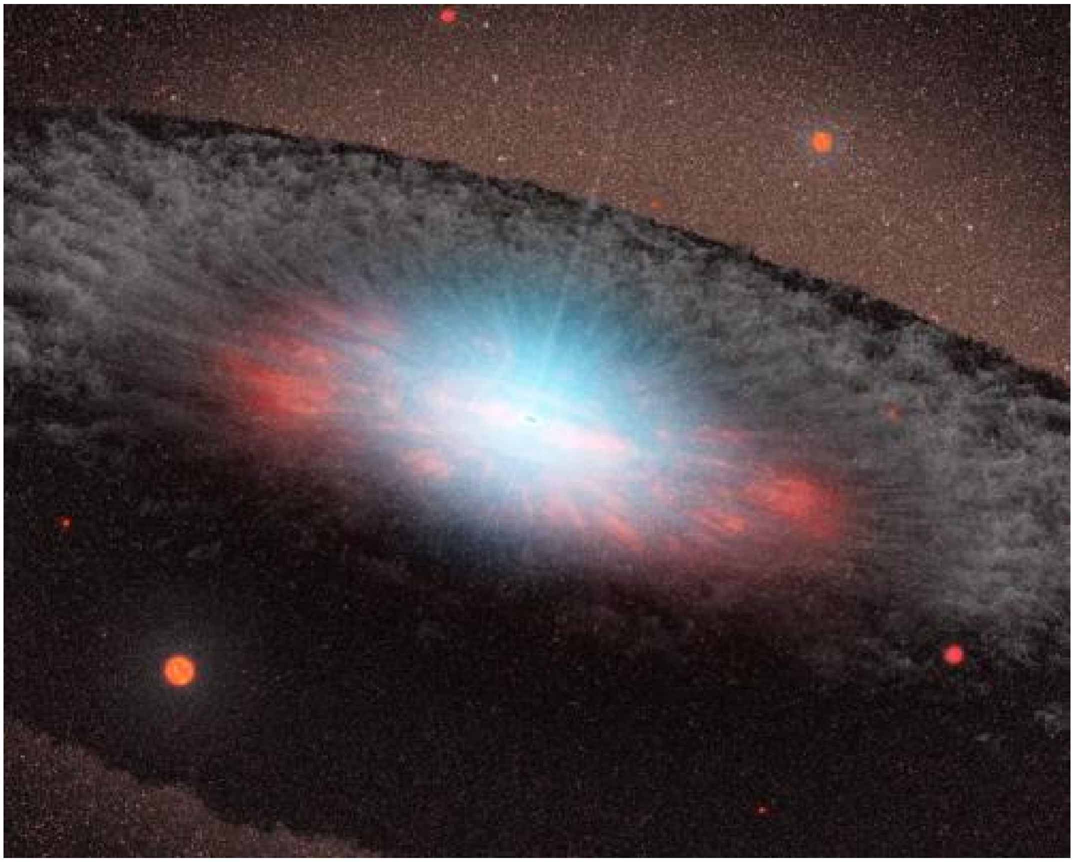

This artist's concept depicts a supermassive black hole at the center of a galaxy. The blue color here represents radiation pouring out from material very close to the black hole. The grayish structure surrounding the black hole, called a torus, is made up of gas and dust. Credit: NASA/JPL-Caltech

(Phys.org) —A team of space scientists working in Italy has found more evidence that suggests the energy needed to emit jets from supermassive black holes comes from the spin of the black hole itself. In their paper published in the journal *Nature*, the team describes how their survey of data from NASA's Fermi Gamma-ray Space Telescope allowed for comparing two types of emissions from the black holes, which showed a correlation.

Scientists know that some supermassive black holes, the kind that typically exist at the center of galaxies, shoot out particles at near the speed of light in a constant stream (aka as jets)—such black holes have accretion disks and because the black hole spins, the jets as viewed from Earth tend to blink—they are generically known as quasars (or blazars if their jets are aligned with us.) What's not been clear is where the energy comes from to support such jets. The general theory is that it most likely comes from the gravitational effect of material in an accretion disk being pulled in. But calculations have suggested that might not be enough to account for the amount of energy needed to produce the jets. In this new effort, the researchers looked at data from NASA's telescope to see if more information could be found to better explain the true source.

The team looked specifically at two types of data. The first was measurements of gamma rays, which showed how bright the jets were. The second was optical observations that showed how luminous the accretion disks were. Plotting them together showed a clear correlation between the two, the team reports, noting that the brighter the disks were, the stronger the jets were. But, the data also showed that the jets were producing more energy than could be accounted for by the accretion disks, which indicates that some other energy source must be involved. That source, the team suggests, is most likely energy from the spinning of the black hole itself.

Unfortunately, it's not yet possible to measure the spin of supermassive black holes, which would add another factor to the equation and perhaps answer the question of where the jets get their energy once and for all. But that should change in 2028 when a European project, the Athena x-ray observatory goes aloft.

More information: The power of relativistic jets is larger than the luminosity of their accretion disks, *Nature* 515, 376–378 (20 November 2014) DOI: 10.1038/nature13856

Abstract
Theoretical models for the production of relativistic jets from active galactic nuclei predict that jet power arises from the spin and mass of the central supermassive black hole, as well as from the magnetic field near the event horizon. The physical mechanism underlying the contribution from the magnetic field is the torque exerted on the rotating black hole by the field amplified by the accreting material. If the squared magnetic field is proportional to the accretion rate, then there will be a correlation between jet power and accretion luminosity. There is evidence for such a correlation, but inadequate knowledge of the accretion luminosity of the limited and inhomogeneous samples used prevented a firm conclusion. Here we report an analysis of archival observations of a sample of blazars (quasars whose jets point towards Earth) that overcomes previous limitations. We find a clear correlation between jet power, as measured through the γ-ray luminosity, and accretion luminosity, as measured by the broad emission lines, with the jet power dominating the disk luminosity, in agreement with numerical simulations9. This implies that the magnetic field threading the black hole horizon reaches the maximum value sustainable by the accreting matter.