RXTE satellite decodes the rhythm of an unusual black hole

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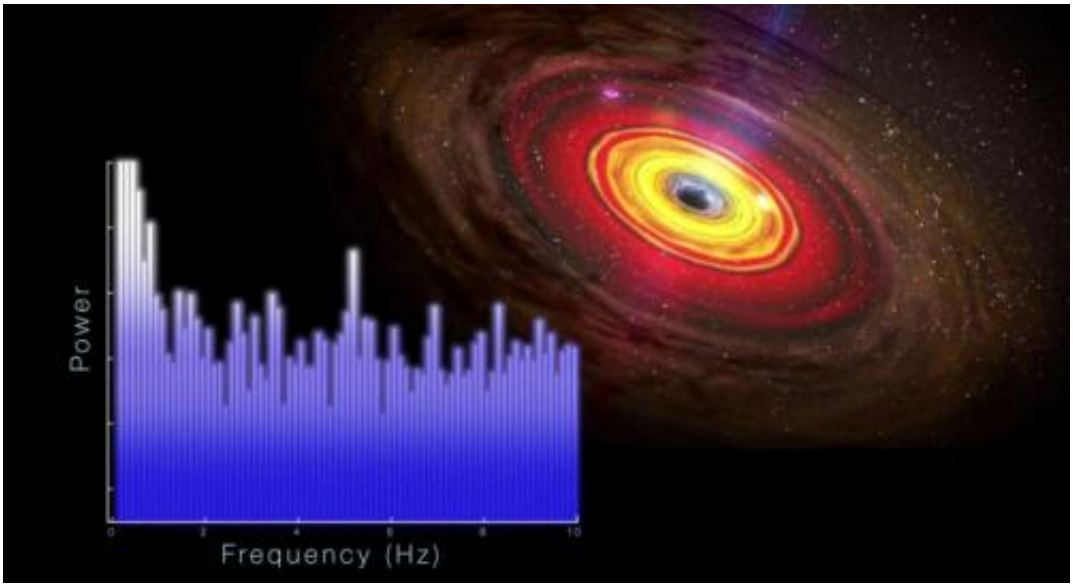

(Phys.org) —Astronomers have uncovered rhythmic pulsations from a rare type of black hole 12 million light-years away by sifting through archival data from NASA's Rossi X-ray Timing Explorer (RXTE) satellite.

The signals have helped astronomers identify an unusual midsize black hole called M82 X-1, which is the brightest X-ray source in a galaxy known as Messier 82. Most black holes formed by dying stars are modestly-sized, measuring up to around 25 times the mass of our sun.

And most large galaxies harbor monster, or supermassive, black holes that contain tens of thousands of times more mass.

"Between the two extremes of stellar and supermassive black holes, it's a real desert, with only about half a dozen objects whose inferred masses place them in the middle ground," said Tod Strohmayer, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

Astronomers from Goddard and the University of Maryland, College Park (UMCP) have suspected M82 X-1 of being midsize for at least a decade, but compelling evidence excluding it from being a stellar black hole proved elusive.

"For reasons that are very hard to understand, these objects have resisted standard measurement techniques," said Richard Mushotzky, a professor of astronomy at UMCP.

By going over past RXTE observations, the astronomers found specific changes in brightness that helped them determine M82 X-1 measures around 400 solar masses.

As gas falls toward a black hole, it heats up and emits X-rays. Variations in X-ray brightness reflect changes occurring in the gas. The most rapid fluctuations happen near the brink of the black hole's event horizon, the point beyond which nothing, not even light, can escape.

Astronomers call these rhythmic pulses quasi-periodic oscillations, or QPOs. For stellar black holes, astronomers have established that the larger the mass, the slower the QPOs, but they could not be sure what they were seeing from M82 X-1 was an extension of this pattern.

"When we study fluctuations in X-rays from many stellar-mass black

holes, we see both slow and fast QPOs, but the fast ones often come in pairs with a specific 3:2 rhythmic relationship," explained Dheeraj Pasham, UMCP graduate student. For every three pulses from one member of a QPO pair, its partner pulses twice.

By analyzing six years of RXTE data, the team located X-ray variations that reliably repeat about 5.1 and 3.3 times a second, a 3:2 relationship. The combined presence of slow QPOs and a faster pair in a 3:2 rhythm sets a standard scale allowing astronomers to extend proven relationships used to determine the masses of stellar-mass black holes.

The results of the study were published online in the Aug. 17 issue of the journal *Nature*.

Launched in late 1995 and decommissioned in 2012, RXTE is one of NASA's longest-serving astrophysics missions. Its legacy of unique measurements continues to provide researchers with valuable insights into the extreme environments of neutron stars and black holes.

A new NASA X-ray mission called the Neutron Star Interior Composition Explorer (NICER) is slated for launch to the International Space Station in late 2016. Pasham has identified six potential middle-mass black holes that NICER may be able to explore for similar signals.

More information: "A 400-solar-mass black hole in the galaxy M82," Dheeraj R. Pasham, Tod E. Strohmayer, Richard F. Mushotzky. *Nature* (2014) DOI: 10.1038/nature13710. Received 25 April 2014 Accepted 21 July 2014 Published online 17 August 2014

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