Unusual gamma-ray flash may have come from star being eaten by massive black hole

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What researchers think the star may have looked like at the start of its disruption by a black hole at the center of a galaxy 3.8 billion light years distant resulting in the outburst known as Sw 1644+57. Credit: University of Warwick / Mark A. Garlick

A bright flash of gamma rays observed March 28 by the Swift satellite may have been the death rattle of a star falling into a massive black hole and being ripped apart, according to a team of astronomers led by the University of California, Berkeley.

When the Swift Gamma Burst Mission spacecraft first detected the flash within the constellation Draco, astronomers thought it was a gamma-ray burst from a collapsing star. On March 31, however, UC Berkeley's Joshua Bloom sent out an email circular suggesting that it wasn't a

typical gamma-ray burst at all, but a high-energy jet produced as a star about the size of our sun was shredded by a black hole a million times more massive.

Careful analysis of the Swift data and subsequent observations by the Hubble Space Telescope and the Chandra X-ray Observatory confirmed Bloom's initial insight. The details are published online today (Thursday, June 16) in *Science Express*, a rapid publication arm of the journal *Science*.

"This is truly different from any explosive event we have seen before," Bloom said.

What made this gamma-ray flare, called Sw 1644+57, stand out from a typical burst were its long duration and the fact that it appeared to come from the center of a galaxy nearly 4 billion light years away. Since most, if not all, galaxies are thought to contain a massive black hole at the center, a long-duration burst could conceivably come from the relatively slow tidal disruption of an infalling star, the astronomers said.

"This burst produced a tremendous amount of energy over a fairly long period of time, and the event is still going on more than two and a half months later," said Bloom, an associate professor of astronomy at UC Berkeley. "That's because as the black hole rips the star apart, the mass swirls around like water going down a drain, and this swirling process releases a lot of energy."

What researchers think the aftermath of a large star being consumed by a black hole at the center of a galaxy 3.8 billion light years distant may have looked like. The event blasted jets of energy from the black hole, one of which pointed directly at our own galaxy, allowing us to be aware of this event- an outburst now known as Sw 1644+57. Credit: University of Warwick / Mark A. Garlick

Bloom and his colleagues propose in their Science Express paper that some 10 percent of the infalling star's mass is turned into energy and irradiated as X-rays from the swirling accretion disk or as X-rays and higher energy gamma rays from a relativistic jet that punches out along the rotation axis. Earth just happened to be in the eye of the gamma-ray beam.

Bloom draws an analogy with a quasar, which is a distant galaxy that emits bright, high-energy light because of the massive black hole at its center gobbling up stars and sending out a jet of X-rays along its rotation axis. Observed from an angle, these bright emissions are called active galactic nuclei, but when observed down the axis of the jet, they're referred to as blazars.

"We argue that this must be jetted material and we're looking down the barrel," he said. "Jetting is a common phenomenon when you have

accretion disks, and black holes actually prefer to make jets."

Looking back at previous observations of this region of the cosmos, Bloom and his team could find no evidence of X-ray or gamma-ray emissions, leading them to conclude that this is a "one-off event," Bloom said.

"Here, you have a black hole sitting quiescently, not gobbling up matter, and all of a sudden something sets it off," Bloom said. "This could happen in our own galaxy, where a black hole sits at the center living in quiescence, and occasionally burbles or hiccups as it swallows a little bit of gas. From a distance, it would appear dormant, until a star randomly wanders too close and is shredded."

Probable tidal disruptions of a star by a massive black hole have previously been seen at X-ray, ultraviolet and optical wavelengths, but never before at gamma-ray energies. Such random events, especially looking down the barrel of a jet, are incredibly rare, "probably once in 100 million years in any given galaxy," said Bloom. "I would be surprised if we saw another one of these anywhere in the sky in the next decade."

The astronomers suspect that the gamma-ray emissions began March 24 or 25 in the uncatalogued galaxy at a redshift of 0.3534, putting it at a distance of about 3.8 billion light years. Bloom and his colleagues estimate that the emissions will fade over the next year.

"We think this event was detected around the time it was as bright as it will ever be, and if it's really a star being ripped apart by a massive black hole, we predict that it will never happen again in this galaxy," he said.

Provided by University of California - Berkeley