Supermassive black holes can feast on one star per year

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Credit: University of Colorado at Boulder

CU Boulder researchers have discovered a mechanism that explains the persistence of asymmetrical stellar clusters surrounding supermassive black holes in some galaxies and suggests that during post-galactic merger periods, orbiting stars could be flung into the black hole and destroyed at a rate of one per year.

The research, which was recently published in *The Astrophysical Journal*, also suggests an answer to a longstanding astronomical mystery about the behavior of eccentric stellar orbits near supermassive black holes and why the seemingly unstable dynamic survives long term.

A supermassive black hole's gravity creates a nuclear star cluster surrounding it, which gravitational physics would expect to be spherically symmetric. However, several galaxies—including nearby Andromeda—have been observed with an asymmetrical star cluster that takes the form of a disk instead. Eccentric disks are suspected to be formed in the wake of a recent merger between two gas-rich galaxies.

Within the disk, each star follows an elliptical orbit that revolves around the supermassive black hole over time. The stars' orbits nearly overlap and interact with each other frequently. Eventually, gravitational disruptions to one star's orbit will bring it too close to the black hole.

"The force builds up in these stellar orbits and changes their shape," said Associate JILA Fellow Ann-Marie Madigan, who led the study. "Eventually, a star reaches its nearest approach to the black hole and it gets shredded."

"We predict that in a post-galactic merger period, a supermassive black hole will swallow one star per year," said co-author Heather Wernke, a CU Boulder graduate student. "That's 10,000 times more often than other rate predictions."

The finding bolsters observational evidence that some galaxies with supermassive black holes at their center have higher stellar mortality rates than others and suggests that eccentric nuclear disks may be more common than initially expected. Further studies could help researchers better understand galactic mergers and the evolution of the universe.

"Andromeda is likely past the peak of this process, having undergone a merger long ago," said Madigan, who is also an assistant professor in CU Boulder's Department of Astrophysical and Planetary Sciences. "But with higher resolution data, we may be able to find younger eccentric disks in more distant galactic nuclei."

More information: Ann-Marie Madigan et al, Dynamical Properties of Eccentric Nuclear Disks: Stability, Longevity, and Implications for Tidal Disruption Rates in Post-merger Galaxies, *The Astrophysical Journal* (2018). DOI: 10.3847/1538-4357/aaa714

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