Scientists fling model stars at a virtual black hole to see who survives

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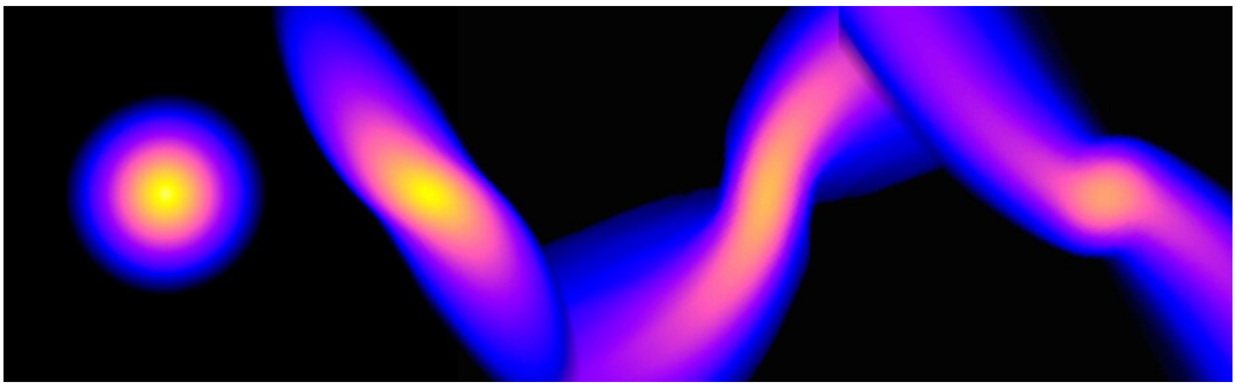

From left to right, this illustration shows four snapshots of a virtual Sun-like star as it approaches a black hole with 1 million times the Sun's mass. The star stretches, looses some mass, and then begins to regain its shape as it moves away from the black hole. Credit: NASA's Goddard Space Flight Center/Taeho Ryu (MPA)

Watch as eight stars skirt a black hole 1 million times the mass of the Sun in these supercomputer simulations. As they approach, all are stretched and deformed by the black hole's gravity. Some are completely pulled apart into a long stream of gas, a cataclysmic phenomenon called a tidal disruption event. Others are only partially disrupted, retaining some of their mass and returning to their normal shapes after their horrific encounters.

These simulations, led by Taeho Ryu, a fellow at the Max Planck Institute for Astrophysics in Garching, Germany, are the first to combine the physical effects of Einstein's general theory of relativity with realistic stellar density models. The virtual stars range from about one-tenth to 10 times the Sun's mass.

The division between stars that fully disrupt and those that endure isn't simply related to mass. Instead, survival depends more on the star's density.

Ryu and his team also investigated how other characteristics, such as different black hole masses and stellar close approaches, affect tidal disruption events. The results will help astronomers estimate how often full tidal disruptions occur in the universe and will aid them in building more accurate pictures of these calamitous cosmic occurrences.

More information: Taeho Ryu et al, Tidal Disruptions of Main-sequence Stars. I. Observable Quantities and Their Dependence on Stellar and Black Hole Mass, *The Astrophysical Journal* (2020). DOI: 10.3847/1538-4357/abb3cf

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