SUPERMASSIVE BLACK HOLES DEVOURING STARS

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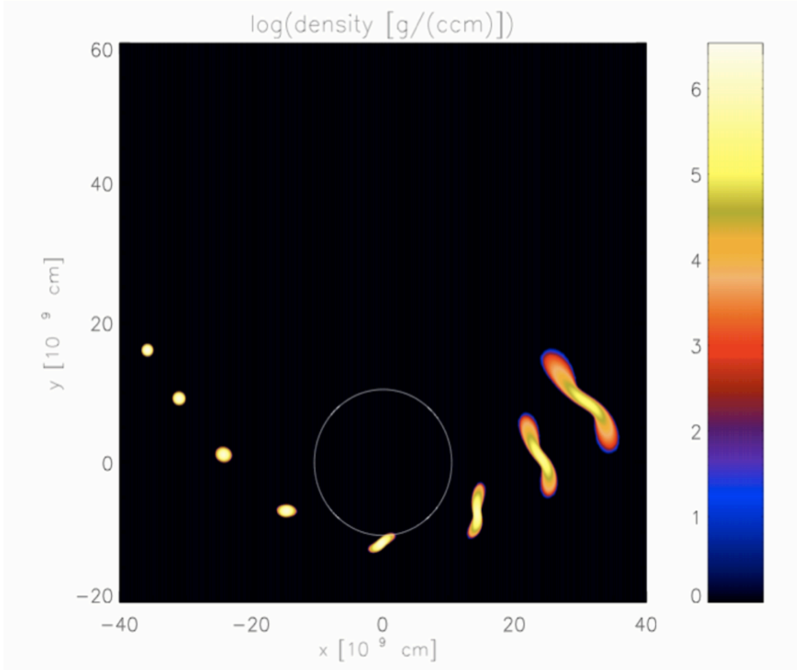
For several decades, astronomers have speculated that a hapless star could wander too close to a super massive black hole and be torn apart by tidal forces, i.e. the difference between the gravitational pull on the side of the star that is close to the black hole and the gravitational pull on the side further away from the black hole. It has only been recently with the advent of numerous wide field transient surveys that the tidal destruction of stars has been detected in the form of giant-amplitude, luminous flares of electromagnetic radiation from the centers of otherwise quiescent galaxies. The discoveries have caused widespread excitement, as we can use these tidal disruption events (TDEs) to study fundamental aspects related to the birth and growth of supermassive black holes in the universe and their relationship with the host galaxies. Studies of nearby galaxies suggest that probably all galaxies with a bulge component harbour such a central supermassive black hole. However, how black holes grow to become super massive is unclear. Gas accretion onto smaller, seed, black holes is likely to be important, but probably limited by the radiative feedback of energy liberated in the process. Mergers of two massive black holes into one might also be important for their growth, but the question is if two massive black holes can be brought close enough such that gravitational wave radiation will cause their merger on short enough timescales. Finally, the mass distribution of the initial seed black holes is also unknown. TDE observations can determine the mass distribution in nearby galaxies, the physics of black hole accretion under extreme conditions including the potential to detect relativistic effects near supermassive black holes, and the physics of radio jet formation and evolution in a pristine environment. In addition, because the rate of TDEs is massively enhanced in binary black hole systems, TDEs are expected to point us to galaxies that are likely to host compact binary supermassive black holes. Finally, TDE can help in pin-pointing the long sought, missing link between black holes with masses similar to those of stars and supermassive black holes. In fact, compact stars like white dwarfs can only be disrupted by intermediate-mass black holes and not by supermassive black holes (In the latter case white dwarfs will only be torn apart after they have crossed the event horizon and those events are thus not observable).



Composite of eight stills from the simulation of the tidal disruption of a white dwarf star by an intermediate-mass black hole by Rosswog, Ramirez-Ruiz & Rix (2009, DOI 10.1088/0004-637X/695/1/404, © AAS. Reproduced with permission) . The location of the event horizon of the black hole is indicated by the white circle at position X,Y=0,0. The colour indicates the density of the material in logarithmic units of g per cubic cm.

The Athena satellite will allow for breakthroughs in the study of supermassive black holes using TDEs in several ways. First, due to the large sky area it will survey and due to the high sensitivity of the instruments, many short duration X-rays flares caused by white dwarf disruptions will be discovered serendipitously, pointing to the locations of elusive intermediate-mass black holes. Secondly, by using the spectroscopic capabilities of Athena, we will be able to measure the properties such as the speed and composition of the outflowing material, allowing the study of the behaviour of feedback on gas flows onto black holes. Finally, Athena's sensitivity will allow the evolution of the amount of X-rays photons emitted as a function of time to be measured accurately, these light curves could reveal the presence of a second, binary supermassive black hole, providing evidence whether or not supermassive black holes also grow by merging with their cousins and nieces.