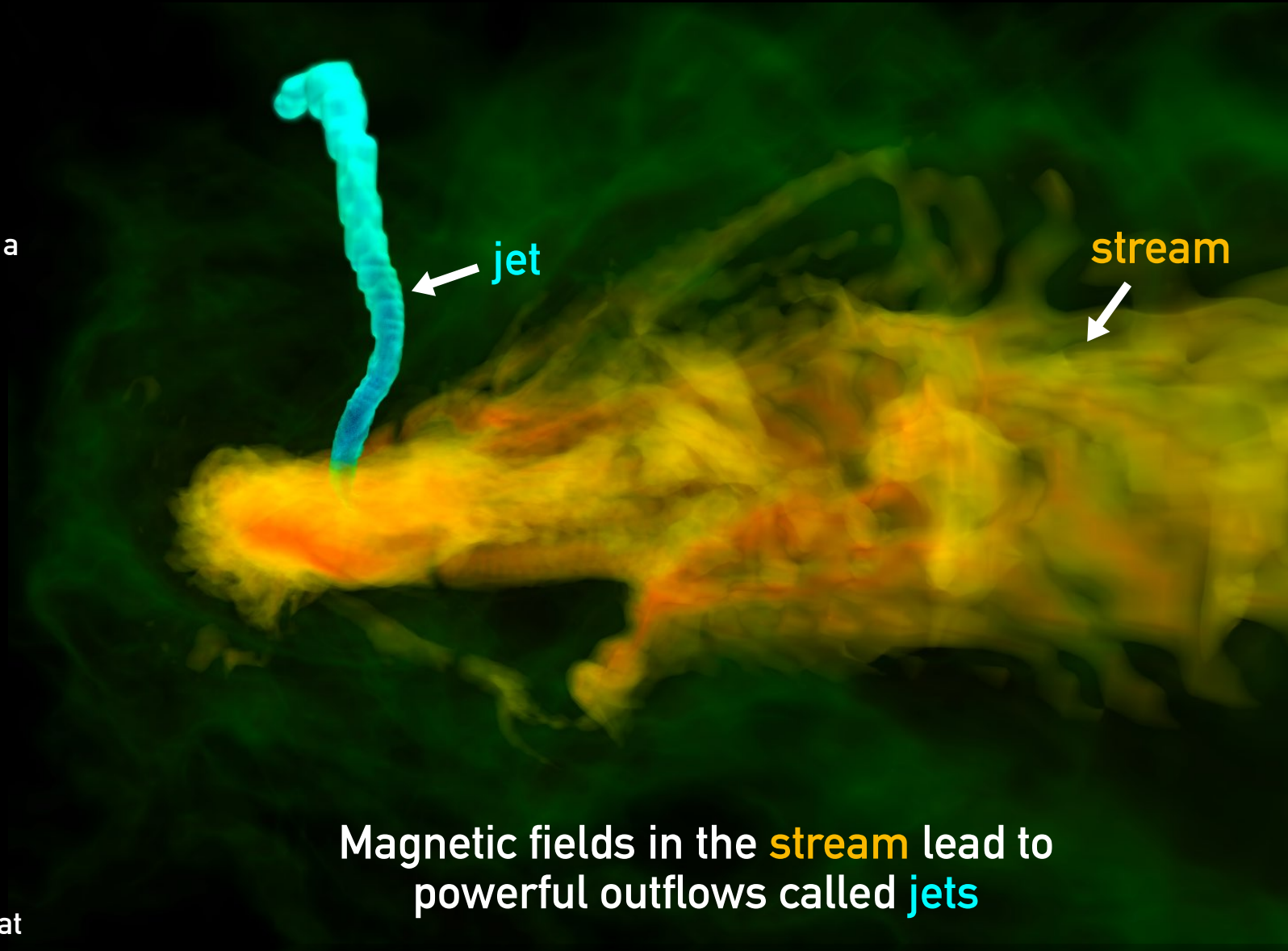
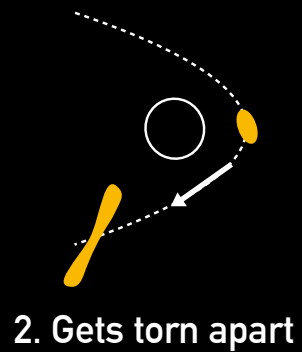
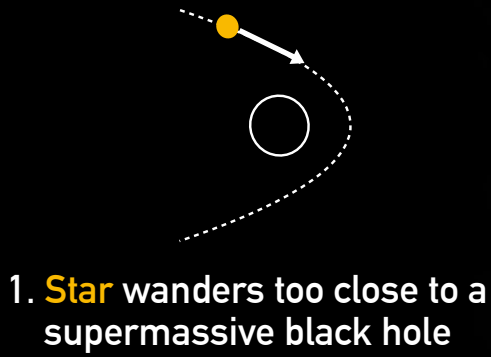


# How a Black Hole Consumes a **Star**: Simulating **Tidal Disruption Events**



**Caption:** When a star gets too close to a supermassive black hole, it gets torn apart by the black hole's gravitational forces in what is known as a tidal disruption event (TDE). The star is pulled into a stream that wraps around the black hole and accretes on the timescale of weeks to months. This process is outlined by the schematic on the left created in Keynote. TDEs serve as a clean laboratory for understanding black hole physics due to the well-constrained gas of the star. Notably, a portion of TDEs have been observed to produce relativistic collimated outflows called jets, but are poorly understood due to debris hiding the central engine. How did these jets come to be?

Using supercomputers (e.g., TACC's Vista, NCSA's Delta), we perform the first end-to-end 3D numerical simulations of a jetted TDE to study the jet's power and ability to break out of the TDE-formed envelope. We begin with the 3D smoothed particle hydrodynamics code GR-PHANTOM which models the dynamics of a Sun-like star being spaghettified by the BH tidal forces. We then remap the outcome of GR-PHANTOM to H-AMR, a 3D GPU-accelerated general relativistic radiation magnetohydrodynamic code that describes the motion of magnetized gas on a curved space-time of a spinning BH.

We use ParaView to visualize a 3D snapshot of the H-AMR jetted TDE simulation at 7.1 days. The colors are based on magnetization, which is the strength of the magnetic field relative to the density of the gas. The yellow-orange stream indicates that the stream is weakly magnetized, and the blue jet (vertical collimated flow) is highly magnetized. The magnetic field of the stream accumulates onto the spinning black hole which is able to launch an electromagnetically-powered jet.