Simulating Binary Black Holes in their Gaseous Environments

Dennis Bowen

Rochester Institute of Technology

ABSTRACT: Supermassive binary black holes (SMBBHs) represent an excellent candidate for future combined gravitational wave and electromagnetic astrophysics, commonly referred to as multimessenger astrophysics. While much is known about the gravitational wave signal of merging BBHs, little is known about the electromagnetic emission. In this talk, I will discuss recent work aimed at pinpointing direct electromagnetic signatures of SMBBHs emanating from the central cavity. We simulated, for the first time in general relativistic magnetohydrodynamics, an astrophysically motivated initial state of the circumbinary accretion disk coupled to individual "mini-disks" around each black hole. We find that general relativistic effects alter the dynamics of gas in this environment in several ways. In addition to the introduction of an azimuthal m=1 mode in the mini-disks, we find that material is quasi-periodically "sloshed" back and forth between the mini-disks on a timescale of hours to days. Furthermore, our mini-disks exist in a state of perpetual inflow disequilibrium due to a quasi-periodic coupling to an m=1 mode, or lump, in the circumbinary disk and relatively rapid inflow times within the mini-disks resulting from the close binary separation. As material is preferentially accreted onto a single, alternating mini-disk at a time, we observe that the mini-disks nearly fully deplete and then refill. Finally, I conclude by discussing preliminary results from general relativistic ray-tracing calculations, which can directly calculate the electromagnetic output of our magnetohydrodynamic simulation.