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Magnetic fields are accumulated along the contact discontinuities which are the boundaries of the jet components and the ambient components surrounding the jet, and the velocity shear leads to a mixing between the jet and ambient gas. When the jet is a galactic object, the surrounding ambient gas becomes neutral hydrogen, and its density is higher than that of the AGN jets. Therefore, the boundary gas of the X-ray binary jet becomes a three-body fluid which consists of electron, ion and neutral hydrogen. On the other hand, for AGN jets, the composition becomes electron, positron and proton because the ambient gas of an AGN jet is low and the cooling is inefficient. The properties of magnetic reconnection in these three-species systems are not yet well understood.

To study the kinetic processes in these environments, we will use PIC simulations with three plasma species using the state-of-the-art PIC code OSIRIS. The PIC simulation method allows the study of fully kinetic, nonlinear plasmas with multiple species, and is a powerful tool for gaining insight into the environments of astrophysical jets. Past work using PIC simulations to model astrophysical electron-positron plasmas has demonstrated that relativistic magnetic reconnection is an efficient mechanism for accelerating nonthermal particles with power law energy distributions. We will study reconnection for the electron-positron-ion plasmas relevant for AGN jets and the electron-ion-neutral hydrogen plasma characteristic of X-ray binaries. Our simulations will include the radiation reaction force for the relativistic electrons and positrons, and the effects of collisional scattering will be included for systems with neutral hydrogen. The nonthermal particle distributions in these simulations will be used to construct radiation spectra that can be compared with observations. Studying the partitioning of dissipated energy into thermal and nonthermal particles and turbulent electromagnetic fields will help guide choices of reduced parameters to be used in magnetohydrodynamic simulations that model the global jet evolution.