Magnetic reconnection has attracted growing attention in many sites in relativistic astrophysics. Although much less was known about “relativistic magnetic reconnection,” there has been significant progress in our understandings of relativistic reconnection in the last decades, largely by means of numerical simulations. In this presentation, I will give an overview of advances in numerical modeling of relativistic reconnection, in kinetic and magnetofluid simulations.

In the kinetic regime, relativistic reconnection has been explored by using particle-in-cell (PIC) simulations. Since the early ages, it was found that reconnection is an efficient accelerator of particles. One problem was that the current-sheet instability might interrupt the reconnection process in 3D; however, recent large-scale simulations have revealed that magnetic reconnection and associated particle acceleration occur in a sufficiently large 3D system. The spectral index of accelerated particles becomes harder in the magnetically dominated regime, because more magnetic energy is available per particle. Relativistic kinetic reconnection is a field of active research now.

In the MHD regime, relativistic resistive magnetohydrodynamic (RRMHD) simulations have allowed us to explore MHD properties of relativistic reconnection. Many properties are found to be straightforward extentions of nonrelativistic ones; For example, the outflow speed is approximated by the relativistic Alfvén speed of inflow plasmas, similarly to the nonrelativistic cases. In addition, various compressible fluid effects are found, such as shocks and supersonic acceleration effects, because a relativistic magnetofluid is highly compressible by nature. Surprisingly, even though they are fundamental issues, the compressible effects have not well understood in nonrelativistic MHD reconnection. In addition to the RRMHD system, several new frameworks have been proposed; Relativistic two-fluid electrodynamics and relativistic resistive radiation-MHD.