Flows in the Magnetotail

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Magnetic reconnection leads to fast streaming of electrons and ions away from the reconnection site. We have used an implicit particle-in-cell simulation (iPic3D) embedded within a global MHD simulation of the solar wind and magnetosphere interaction to investigate the evolution of electrons and ion flows in the magnetotail. We first ran the MHD simulation driven by solar wind observations and then used the MHD results to set the initial and boundary conditions for the PIC simulation. Then we let the PIC state evolve and investigated the electron and ion motion. Within a few seconds of the onset of reconnection, electrons near the reconnection site stream earthward at 500-700 km/s while the ions move at less than 100 km/s. For electrons, magnetic trapping occurs very close to the reconnection site and they move mostly in the $\mathbf{E}$ x $\mathbf{B}/B^2$ velocity. Ion trapping occurs several Earth radii from the reconnection site about 100 s after the start of reconnection where both the electrons and ions move together at $\sim\mathbf{E}$ x $\mathbf{B}/B^2$ velocity.

Although the particles are moving at the $\mathbf{E}$ x $\mathbf{B}/B^2$ velocity, they are in a state defined by the kinetic physics not the state that exists in the MHD simulation.