Particle acceleration during magnetic reconnection studied by PIC simulations

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Particle acceleration during magnetic reconnection is investigated by using particle-in-cell (PIC) simulations. Magnetic reconnection is widely believed to play an important role on plasma heating and acceleration in various environments in space, since it rapidly converts stored magnetic energy into plasma energy. In the Earth's magnetosphere, magnetic energy stored in the magnetotail due to the successive magnetic reconnection in the dayside magnetopause during southward IMF is released by the magnetic reconnection in the magnetotail resulting in the significant plasma energization as well as geomagnetic disturbances. We performed PIC simulations of driven reconnection to investigate in detail acceleration mechanisms of both ions and electrons. We succeeded in producing nonthermal ions in addition to nonthermal electrons in single X-line reconnection. Nonthermal electrons are accelerated by (1) the surfing acceleration in the reconnection separatrix region, (2) meandering motions in the X-point, and (3) gradient/curvature B drift in the magnetic pileup regions, as has been already reported in past studies. On the other hand, we found that nonthermal ions are first accelerated significantly by the meandering motions in the extended ion diffusion region followed by further acceleration in the magnetic pileup region due to the gradient/curvature B drift. We also performed parameter surveys to investigate the conditions necessary for the efficient particle acceleration. We found that the extended ion diffusion region as well as large reconnection electric field are crucial for the efficient ion acceleration.