DPP17-2017-001776

Abstract for an Invited Paper
for the DPP17 Meeting of
the American Physical Society

Electron heating and acceleration during magnetic reconnection

JOEL DAHLIN, NASA Goddard Space Flight Center

Magnetic reconnection is thought to be an important driver of energetic particles in a variety of astrophysical phenomena such as solar flares and magnetospheric storms. However, the observed fraction of energy imparted to a nonthermal component can vary widely in different regimes. We use kinetic particle-in-cell (PIC) simulations to demonstrate the important role of the non-reversing (guide) field in controlling the efficiency of electron acceleration in collisionless reconnection. In reconnection where the guide field is smaller than the reconnecting component, the dominant electron accelerator is a Fermi-type mechanism that preferentially energizes the most energetic particles. In strong guide field reconnection, the field-line contraction that drives the Fermi mechanism becomes weak. Instead, parallel electric fields are primarily responsible for driving electron heating but are ineffective in driving the energetic component of the spectrum. Three-dimensional simulations reveal that the stochastic magnetic field that develops during 3D guide field reconnection plays a vital role in particle acceleration and transport. The reconnection outflows that drive Fermi acceleration also expel accelerating particles from energization regions. In 2D reconnection, electrons are trapped in island cores and acceleration ceases, whereas in 3D the stochastic magnetic field enables energetic electrons to leak out of islands and freely sample regions of energy release. A finite guide field is required to break initial 2D symmetry and facilitate escape from island structures. We show that reconnection with a guide field comparable to the reconnecting field generates the greatest number of energetic electrons, a regime where both (a) the Fermi mechanism is an efficient driver and (b) energetic electrons may freely access acceleration sites. These results have important implications for electron acceleration in solar flares and reconnection-driven dissipation in turbulence.