Energy Partitioning of Magnetic Reconnection in Electron-Ion Plasmas

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Magnetic reconnection is a fundamental process in magnetized plasmas that drives plasma energization in diverse environments, from the solar corona to Earth's magnetosphere. This process converts magnetic field energy into plasma kinetic energy, driving plasma flows, thermal heating, and the acceleration of particles into nonthermal distributions with power-law energy spectra. In electron-ion plasmas, the division of this energy into thermal and nonthermal components for each species remains poorly understood, yet is essential for interpreting observations. In this study we investigate the energy partitioning of reconnection in electron-ion plasmas using two-dimensional particle-in-cell (PIC) simulations with a mass ratio of 100, spanning a range of conditions from non-relativistic to highly relativistic regimes. By fitting particle energy spectra, we separate the thermal and nonthermal components for each species, quantifying the fraction of particles and energy in each. A parameter scan reveals an increase in nonthermal particle and energy fractions with increasing initial plasma temperature, and how the current sheet conditions affect the power-law indices and electron-ion temperature ratios. Using self-consistent particle tracking, we investigate the physical mechanisms underlying the differential heating and acceleration of electrons and ions. These results provide new insight into particle energization from reconnection and have broad relevance for reconnection-driven dynamics in electron-ion plasmas throughout space and astrophysical systems.