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The Dominant Acceleration Mechanism and Formation of Power-law Particle Energy Spectra in Spontaneous, Turbulent and Forced Relativistic Magnetic Reconnection FAN GUO, Los Alamos Natl Lab, XIAOCAN LI, Dartmouth College, YINGCHAO LU, HUI LI, WILLIAM DAUGHTON, PATRICK KILIAN, Los Alamos Natl Lab, YI-HSIN LIU, Dartmouth College —
While a growing body of research indicates that relativistic magnetic reconnection is a prodigious source of particle acceleration in high-energy astrophysical systems, the primary acceleration mechanism and formation of power-law energy spectra remain controversial. We have developed a series of fully kinetic simulations and theoretical analysis for discerning the primary acceleration mechanism. Our analysis statistically evaluates the acceleration of a large number of particles, and therefore can distinguish contributions of different acceleration mechanisms without bias. We apply these analyses to several applications including spontaneous reconnection, 3D relativistic turbulent magnetic reconnection, and forced reconnection when current sheets cross a shock. We show consistently that relativistic magnetic reconnection in the low guide field regime accelerates particles to high energy via Fermi acceleration in relativistic flows generated during reconnection. We further provide analytical derivations for the development of power-law energy spectra. The analysis shows the critical roles of particle injection and Fermi acceleration. The escape term does not lead to power-laws, but it is important in determining the eventual shape of the spectrum.
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